



NORTHERN ARIZONA



Telecommunications Summary and Planning Guide - 2004

NORTHERN ARIZONA TELECOMMUNICATIONS PLAN 2004

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GREATER FLAGSTAFF ECONOMIC COUNCIL

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"Would you tell me please, which way I ought to go from here?" said Alice.

"That depends a good deal on where you want to get," said the cat.

"I don't much care where," said Alice.

"Then it doesn't matter much which way you go," said the cat.

-Lewis Carroll
Alice in Wonderland

EXECUTIVE SUMMARY

The key to figuring out how to get somewhere is knowing where you are to begin with...

That said, it is beneficial to everyone this Plan touches to have a common perspective from which to address the telecommunications needs in Northern Arizona. We must all understand how and why fulfilling those needs is not a simple task. We must address all the aspects of a dynamically changing set of technologies, consumers, regulations *and* regulators, service providers, market dynamics, and the interrelationships amongst them. And things change..... frequently.

From a *technology* perspective, examining the telecommunications foundation and its inter-connectivity (the information flowing into and out of all access points in Northern Arizona today) can be a daunting task - but is an essential one to "find out where you are." Then comes the even more challenging task of figuring where you are trying to go. To do that, this Plan must address not only traditional telecom services, but also focus on defining ways to provide systematic upgrades that revitalize what exists into "digital" foundation capable of being evolved into a system that accommodates vastly improved voice and high speed data services, and the growing requirement for video capacities in our data networks as well.

The complexity of technologies can be overwhelming enough. But the difficulties with creating, operating and evolving these networks are



magnified by *people* factors. These people factors must take into account things like multi-tiered, often conflicting government regulation (i.e., federal, state *and* local), licenses and access rights both by and among providers as they are needed to implement services, basic business models that determine whether it makes sense to invest and deploy these new services (i.e. Capital Cost vs. Return on Investment-ROI), inter-company and/or inter-personal relationships, and must even take into consideration the indirect, decision-steering factors like the downturn in telecom markets over the last 18 months. The list could go much farther....

It is worthwhile to review briefly some of those factors and how they may affect the planning and implementation process to raise the overall level of services in Northern Arizona to at least a parity level with metropolitan Arizonans - e.g., in Phoenix or Tucson.

RECENT EVENTS

The tidal wave of troubles that hit telecom came hard and fast in early 2001, and in the past two years we have seen dramatic declines in market valuations:

WorldCom: once a darling of Wall Street, trading as high as \$64.50 in June 1999. It's now in the midst trying to recover from the largest corporate failure in US history.

Qwest: facing a multitude of problems. It traded for over \$40.00 a year ago; dipped under \$3.00 per share in late 2002, bordering junk stock classification.

AT&T: posted a loss of \$975 million in 1Q02, or 28 cents a share, on revenue of \$12.02 billion, compared with a loss of \$192 million (10 cents a

share) on revenue of \$13.55 billion during the same period a year earlier.

Cellular stocks: have also been hard hit. Since this time a year ago, AT&T Wireless' stock has dropped almost 60%. And, Nextel's value dropped almost two-thirds - from over \$16.00 per share to less than \$5.00.

Layoffs: in the telecommunications sector have also been surging, rising to almost 500,000 people in 2001/2002¹ - that's almost double any other industry. Telecom companies, equipment manufacturers, and component suppliers all feel the cascading effects of the slump.

What's more we have seen an unprecedented number of telecom bankruptcies. There is a long laundry list of casualties stemming from the startup investments created by the 1996 Telecom Act. that includes: Covad Communications, Rhythms NetConnections, Metricom, PSINet, Teligent, Viatel, WinStar Communications, Pathnet Telecommunications, e.spire Communications, Omniplex Communications Group, Northpoint Communications, Flascom, ICG Communications, most recently, Williams Communications....who owned over 33,000 miles of the most up-to-date fiber laid to date; . . . and the list goes on.

We can all debate the causes of the telecom tsunami. Bad business plans? Bad government policies? Bad accounting practices? Bad financial advice? Too much capital chasing too few customers? Dot Com boom becoming the dot bomb bust? Post-September 11th economic malaise? Or the direct result of the power base maintained by the Baby Bells' monopoly?

The purpose here is not to rummage through the past, but it is helpful to understanding what is on the global minds of the Telecom industry's upper management when laying out a plan that solicits their cooperation and enormous investment. It is also to highlight what is foreseen as the major

challenges ahead for the Federal Government (through the FCC), the State of Arizona (through the Department of Commerce, Corporation Commission, and Information Technology Agency), and even local governments as they are rapidly focusing in on key issues. The upper levels of even Wall Street are joining in to address the challenges.

BROADBAND AS A SOURCE OF GROWTH AND INVESTMENT

Broadband. As a widely used term, it has captured the attention of most as the Holy Grail in our future ... the lightning fast means of data transmission that could revolutionize the way we all send and receive information. It is envisioned to enhance business efficiencies, broaden commercial opportunities, even offer whole new ways to function, business-wise *and* personal-wise, in our daily lives. Broadband holds the promise of expanding educational opportunities, improving health care, increasing governments' responsiveness to its citizens, and generally enhancing our global competitiveness. Thousands of new jobs could result from greater broadband deployment², both directly through network construction, and indirectly through industries related to advanced networks and services. Not surprisingly, then, broadband is an important potential source of growth and investment for Northern Arizona, notwithstanding the nation as a whole.

Trying to define it is another story. Broadband serves today as the posterchild for an even more enigmatic buzzword, *convergence*. Convergence is exciting and ripe with opportunities, but it presents serious challenges for the regulator - how to remove regulatory impediments and ensure full and fair competition among different platforms that currently operate under very different regulatory regimes (cable versus telecom versus wireless and/or satellite companies). On the demand side, there is an equally challenging issue of figuring out why more people aren't seeing the possibilities and pressing expansion to the next level.

¹ The Telecom Industry - with the vision of new-found competitive opportunities spawned from the 1996 Telecom Act - created nearly 250,000 jobs from 1996 to 2000, when competitive entries to the market began collapsing. Many of the reasons cited above can be attributed to not only the loss of most of those jobs, but also an additional 250,000 in 2001-2002.

² A U.S. Department of Commerce study in 2001 estimated a cumulative boost to the economy of nearly \$500 Billion by the year 2010 would result if affordable broadband were widely available starting in 2002.

The Federal government³ and State of Arizona Departments of Commerce are working on both these supply- and demand-side issues. A recent U.S. Department of Commerce study based on 2000 census data indicated that:

- 60.2 million U.S. households had a personal computer;
- 53.0 million U.S. households subscribed to the Internet;
- 10.6 million U.S. households connected to the Internet via broadband

These findings appear to indicate that the public has not fully embraced broadband services. What needs does broadband serve that cannot be met effectively by other means? Why are so many consumers and small businesses declining to subscribe to high-speed Internet access services? Should the state be concerned about low rates of subscribership? From an *overall* economic positioning perspective, experts say yes. However, the general preference as expressed by sales/revenues indicate that the preferred use of discretionary income applicable toward broadband service has in fact steered toward cellular telephony (by a factor of nearly 10:1). Narrowband (dial-up) connections to the Internet allow users to do most basic things - like send and receive e-mails, browse most web sites, buy products from e-commerce web sites, participate in online auctions, and download files for offline use. Even users with dial-up service are capable of transferring large data files, such as video clips, if they have the time and a reliable connection. But broadband is far superior for all these tasks:⁴

³ The National Telecommunications Industry Association convened a Broadband Forum in the fall of 2001, and requested public comments on the issues and extensively engaged public interest groups, industry representatives, academics, and other interested parties in discussions on broadband issues. NTIA's sister agency at Commerce, the Technology Administration, focused more on demand-side issues, convening workshops on digital rights management and the benefits of broadband to small business.

⁴ For a comprehensive summary on how online Americans benefit from broadband, please access the attached report by the Pew Internet & American Life Project Report, "[The Broadband Difference](#)," (hyperlinked to the report on disk) or at the author's website: www.pewinternet.org.

Broadband enriches online activities by providing a considerably larger pipe for data to flow through. It also offers features, including the potential for web-based applications, that narrowband simply cannot provide, such as:

- The ability to send and receive large amounts of data quickly, practically in real time
- A reliable connection that is "always on"
- Effective capabilities for telecommuting and videoconferencing, so that a person could work at home or attend a meeting or conference without traveling
- Rich multimedia applications and games
- The capability to conduct fast, secure e-commerce and large-scale business-to-business transactions
- Telemedicine services
- Opportunities for distance learning and job training from the home, and
- The benefits of virtual collaboration on projects among people in different locations

The telecommunications equation is very complicated. In order for broadband to be successful in rural Arizona, it must be affordable. In order to be affordable, it must be ubiquitous (which implies competitively available from multiple sources). So the key issues are not whether to deploy xDSL, cable modems, wireless solutions, fiber-to-the-home, or any combination of today's technologies to serve as the broadband foundation. Each has its merits in the right scenario. The basic infrastructure - i.e., adequate middle-mile infrastructure - *must exist* first though. As of Fall 2003, this is not true. And the regulatory factors, the business factors...the aspects controlled by *people* functions... make the process difficult. Knowing and understanding that part as well as the technologies are the elements of the equation that will enable this to serve as a successful Plan - by identifying the specific challenges over next few years - as Arizonans progress from *broadband* infancy toward *convergence*, and then onward to the next telecommunications epoch. It is anyone's guess what that will be called...

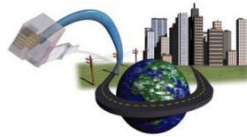
In the interim, we are faced with developing an executable strategy that positions Arizonans with the basic network foundation that enables broadband adoption throughout rural areas similar to their

metropolitan counterparts. That foundation is severely lacking today. The purpose of this plan is to do the following things:

Identify inhibitors to broadband expansion - be they cost, technology, or regulatory related

Identify solutions to each that minimize the impact on public funding as well as maximize the benefit to all Arizonans.

An formidable task? Certainly. An impossible one? As Arizonans, we should all hope not! And this Plan should serve as a starting point.





TELECOMMUNICATIONS OVERVIEW

A snapshot of applicable technologies...

A solid overview of the most prominent broadband technologies is worthwhile, since it will address each technology's capability to meet a community's needs. It will explain the fundamental infrastructure components, the physical network capabilities. And most important, it will provide a list of limitations on the uses of each physical network type. This type of tutorial is paramount to engaging in discussions with providers that are most well suited to meet each community's needs. Later in this document, each community will be "profiled" in a way that provides demographics, environmental factors, economic issues and network foundation(s) that exist upon which a solid set of recommendations can be made to meet near- and mid-term objectives, and establish a baseline from which to begin formulating long-term infrastructure upgrade requirements.

TECHNOLOGY TRENDS

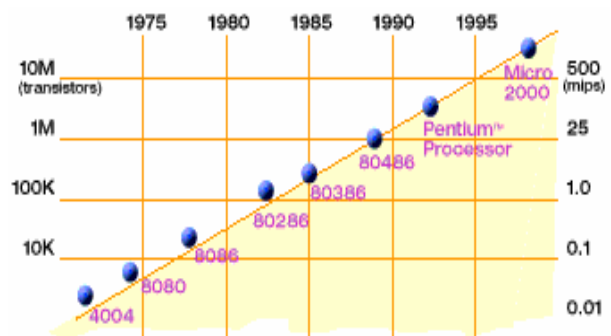
Computing is the technological driving force behind the rapidly evolving telecommunications industry. Every aspect of telecommunications today is impacted by developments in computer science. From hand-held cell phones to satellite links to telephone switches and new TV standards, each development is made possible by advances in computing capacity, speed, reduced power consumption, and compactness.

MOORE'S LAW AND DECLINING COSTS

In 1965, Gordon Moore, one of the founders of Intel, first forecasted that computer chip complexity

would double every 18 months, with each new chip containing roughly twice as much capacity as its predecessor, thereby producing an exponential rise in computing power.

Moore's observation, now known as Moore's Law, described a trend that has continued and is still remarkably accurate. It is the basis for many planners' performance forecasts. In the last 26 years processors have evolved from 4 and 8-bit CPUs to 64. Along with that, speeds have increased from a few megahertz to over 3 gigahertz.



Perhaps the most significant trends are the rapidly declining costs involved with processing, storing, and distributing information. Between 1991 and 1995, the cost to store a Gigabyte of data, equal to eight billion bytes, has dropped from about \$12 to just over \$1 for hard drive storage, and less than \$1 for CD-ROMs. And the cost to send a Megabyte, or eight million bits of data, from New York to Los Angeles via modem, has dropped from about \$1 to about 12 cents. (All these examples are in constant 1995 dollars.) These trends are expected to continue.

CONVERGENCE

Convergence is now a fundamental force in telecommunications. There are primarily three types of convergence:

Media convergence--exemplified by the World Wide Web, viewers look at video screens that combine elements of audio, video, animated graphics and print media. For example, some sites have background music upon entrance, graphics and text may be animated, and there may be streaming IP video components, as well as plain text to read. But media convergence also refers to what was formerly known as teletext, now referred to as InterCast or simply sending data with video using WebTV.

Network convergence--exemplified by cable modems, which are not really modems but do connect your home computer to the outside cyber-world via the coaxial cable TV cable that once was a one way pipe for sending video to your home and can now offer video, Internet and telephony services. In Italy, an electric company has started offering Internet access over their electric wires.

Business convergence--Giant telephone company AT&T buys cable giant TCI, for example. Disney buys Capital Cities/ABC television network, as well as Starwave, a leading Web production and design firm, the company that designed the well regarded ESPN (also owned by Disney) Web site; Microsoft and NBC enter into an alliance to form MSNBC.

Ultimately, convergence means that instead of long distance or local voice telephone service being the battleground for customer dollars, the fight will likely be over Internet service. The ability to offer fast Internet service at low cost will be the battleground because the Internet provides converged service. This converged service will be the means for making a voice call (with or without live video), sending and receiving e-mail (featuring any combination of text, video, voice and graphic elements), conducting business transactions, accessing government services and of course surfing the web. Voice telephony may rapidly become just one among many features. It would not be surprising if voice service, in some settings, became a "loss leader" offering as part of the package,

because voice traffic is a relatively low bandwidth application and, ultimately, the data stream does not distinguish one bit from another, and all of the various media will be transmitted as interwoven, multiplexed, packet data bit streams.

As communications technologies converge, the market will create new opportunities for competition and innovation; however there will also exist the potential for anti-competitive and discriminatory conduct by new and altered convergence market participants. Network convergence thus requires some regulatory oversight, yet it is precisely the current deregulatory atmosphere, in conjunction with digital communications, that is fostering network convergence. The challenge and opportunity presented to government regulators of network carriers then, is to facilitate the transmission of the historically separate communications networks towards the digital communications-based network convergence to enable ultimate consumer benefits. At the same time, regulators must ensure adequate antitrust oversight for potential discriminatory and anticompetitive behavior by network carriers in the network convergence market.

Over the next decade, the global telecom market will be "radically different." The network of the future will be all-digital, broadband, "always on," ubiquitous, and "intelligent," and the old regulatory structures, based on analog technology, must be updated to keep pace with technology. Otherwise, regulators might inadvertently undermine the public interest without even knowing it.

VOICE OVER IP

Another major trend making rapid advances in the telecommunications marketplace is the conversion of voice telephony running over broadband data circuits - commonly called Voice over IP (VoIP). Since many multi-sited businesses already operate high-speed data networks among existing facilities, and since voice represents a relatively small bandwidth requirement, it goes without saying that significant savings can be achieved by eliminating traditional telephony systems. In addition, the level of integration of "smart phones" with existing PCs and workstations permit the implementation of

integrated applications that significantly improve work-flow communications.

Some of the most significant benefits and drivers to shifting to VoIP include:

- Fewer networking people to support business requirements
- Providing enhanced voice services like 3-way calling, conferencing
- Ease of deploying integrated PC-telephony applications
- Cost of domestic calls between company sites and offsite drop significantly
- Cost of international calls drop significantly
- Ongoing cost of upgrading and maintaining traditional PBXs drop significantly
- Cost of moves/adds/changes drop significantly
- Cost of wiring drops significantly
- Extendable in a private network even to employee residences

On the flip side of the benefits, there are issues with VoIP that continue to affect consumer acceptance and deployment of this technology. These include:

- The benefits of VoIP are not compelling enough to deploy systems at this time
- Lack of budget
- The lack of people to plan, design, implement and manage VoIP
- Fear that issues with quality of service (QoS) make VoIP not ready for deployment
- Broad deployment of VoIP is not easily managed, and therefore hidden costs exist
- Concerns about interoperability between vendor's equipment

VoIP technology has evolved quickly, and though there are still many valid concerns to consider before making a leap of faith - any potential decision to deploy should be based on an "absolute" set of requirements vendors shall meet before implementing. Careful planning is paramount based on the state of technology today. There is, however, an expectation that this technology will become ubiquitous in the coming years.

For the time being, VoIP hasn't become a primary threat to telephone companies' service revenue. But

that is changing, and as compatible Quality of Service implementations expand, so will the migration toward VoIP. This capability will even begin to penetrate the residential markets as broadband connectivity expands. The key to enabling VoIP to expand in the commercial markets will be driven by expansion in the number of VoIP gateways, which are the essential equipment nodes that make the transport of voice over data circuits a reliable alternative to traditional PSTN telephony.

Where is VoIP going in 2004?

This is the year that enterprise IP telephony hits full stride with advanced product features and more large-scale user deployments, experts predict. Remote-office resiliency, wireless voice over IP, and expanded server platforms and protocol support are some of the items IP PBX users want - and VoIP vendors say customers can expect - in 2003.

Sales of the equipment reached approximately \$1.4 billion in 2002, according to Synergy Research Group, which expects the market to reach \$5.2 billion by 2006. Many VoIP companies are now on their third and fourth generations of gear, and large integrators such as IBM Global Services are fortifying offerings with packaged installation and management services for enterprise IP voice.

Support for Session Initiation Protocol (SIP) is on the road map for a few IP telephony vendors in 2004. SIP is an IETF standard that will let customers use IP networks to establish sessions, instead of just phone calls, which could include voice, video or instant-messaging communications. The protocol also can be used in "presence" applications, where users list themselves as available (similar to a "buddy list") via a SIP URL. This allows users to be reached via whatever SIP-enabled technology is available: phone, videoconferencing or instant messaging. Some industry observers see the protocol as the successor to H.323, which is used widely in corporate IP telephony phones and IP PBXs today. SIP will play an instrumental role in the maturation of the IP telephony market, and once SIP becomes ubiquitous telephony will be like Ethernet . . . cheap components that are interoperable.

Several IP PBX vendors have announced SIP-based IP PBXs, including Nortel and Mitel, while others, such as Avaya and Alcatel, have said SIP will be a part of their IP telephony strategy in the near future. Cisco offers a SIP-based phone, but no native support for the protocol on its CallManager phone server [yet].

Alcatel and Polycom are two companies that have made SIP support a priority for 2003. Alcatel expects to announce support for SIP phones for its hybrid IP/TDM OmniPCX phone switch in the first quarter. Polycom, which had demonstrated a SIP phone at the Fall Voice on the Net conference, will have a production unit available this year. The company also is targeting a SIP-based IP teleconferencing station for release in mid-2003.

Merging wireless and IP telephony

In addition to SIP, some vendors and users will look to merge the worlds of Wi-Fi networks and IP telephony in the coming year. 802.11 voice is expected to become a very important application for the enterprise. Cisco wireless networking business unit is confident of that, and Cisco is the market leader in both enterprise wireless LAN and VoIP. IP telephony in 2004 - Trends to look for from enterprise IP telephony gear makers:

- Platform expansion
- Some vendors will look to move their IP PBX platforms off of Windows-based servers and onto boxes running Linux, Unix or even proprietary systems.
- Wireless VoIP
- Makers of IP telephony gear will embrace wireless LAN and cell phone technologies.
- SIP proliferation
- Stronger support for SIP, as vendors aim to handle converged applications.

Wi-Fi-based VoIP will get attention by Cisco and other vendors. Cisco's CallManager interoperates with wireless IP phones from wireless LAN rival Symbol Technologies and wireless LAN IP phone specialist Spectralink. Some users say a Cisco-branded Wi-Fi phone might be on the horizon. Avaya also offers wireless LAN IP phones from Spectralink. The company also makes a softphone product that can be used on a PDA. Many other

features and functions are being addressed in product offerings by Alcatel, Siemens, and Avaya. Issues that need improvement include:

- Remote-site survivability
- Graceful WAN link degradation
- Disaster recovery
- Alternative server platforms (Unix and Linux)
- New Java-based IP telephony applications

DIGITAL TELEVISION

The following Q&A is provided by the FCC regarding the national shift to Digital Television.

What is Digital Television (DTV)?

DTV is a new type of broadcasting technology that will transform television as we now know it. DTV technology will allow broadcasters to offer television with movie-quality picture and CD-quality sound, along with a variety of other enhancements. DTV technology can also be used to transmit large amounts of other data into the home, which may be accessible by using your computer or television set.

Why Is DTV Important and Why Is DTV Happening?

With DTV, broadcasters will be able to offer television with higher resolution and better picture quality than what exists under the current mode of TV transmission. With DTV, much more information may potentially be available on your television set, including additional channels. DTV will also free up parts of the scarce and valuable broadcast airwaves, allowing the government to use those portions of airwaves for other important services, such as public safety services (i.e., police, fire departments, rescue squads, etc.).

When Will Broadcasters Complete Their Transition to DTV?

The transition to DTV is a tremendous undertaking – and one that is well under way. The FCC has already established rules and a plan to move all television station licensees to DTV.

As part of the DTV transition, each existing television licensee received a paired digital channel

for digital transmission, in addition to its analog channel, used for regular television service. After the transition, broadcasters will have to surrender the analog channel to the FCC for auction.

More than 450 stations are currently on the air with DTV signals, and, with the proper equipment, approximately 88% of American households could receive at least one DTV signal. All analog television licensees are expected to make the transition from analog to digital transmission by December 31, 2006.

Will I Be Able to Continue Receiving "Regular" Television and Use My Regular Set and Antenna?

Consumers will continue to receive analog television service until a majority of the viewing public can receive digital service. A law passed by Congress in 1997 allows for the continuation of analog service beyond the year 2006 if DTV service and equipment are not as widespread then as is currently anticipated.

During the transition period, consumers who wish to view analog programs can continue to use their existing sets. They will not be able to see the DTV broadcasts, however, without a DTV-compatible set or a special converter. Consumers who wish to keep their existing sets can purchase converters that will allow them to view digital programs on their current sets.

In general, DTV will require the same type of signal reception equipment that currently works for good quality reception of analog TV signals. If you need a rooftop antenna in order to receive analog television reception, the same antenna generally will be needed for DTV.

How Much Better Is the Resolution of DTV Compared to Current Analog TV?

Most analog television broadcast stations transmit a picture that contains 480 vertical interlaced lines with approximately 340 horizontal pixels per line. DTV sends pictures that contain 1080 vertical interlaced lines with 1920 horizontal pixels per line, making the resolution much better.

High Definition Television (HDTV)

HDTV is television with theater-quality pictures and CD-quality sound. Broadcasters can use the DTV system to offer HDTV. They can also use DTV to offer several different non-HDTV (or standard definition) programs at the same time (see above), with better pictures and sound quality than is generally available over analog channels today. In addition, a broadcaster can simultaneously transmit a variety of other information, such as stock market quotes or interactive education materials, as part of its standard DTV broadcast to both enhance its TV programs and to provide entirely new services.

What Will the New DTV Sets Look Like and What Will They Cost?

New DTV sets have wider screens than current TVs, allowing you to view pictures that are more like those in a movie theater. The wider screen is expected to enhance sports and drama viewing, making you feel more involved in the action, as well as rendering more realistic pictures. As with current TV sets, a range of sizes eventually will be available.

Just as color televisions were very expensive when they were first introduced, the new DTV-compatible sets are still costly, with manufacturers concentrating initially on "high-end" models. The price has already begun to drop, however, and will continue to do so over time. By the time DTV broadcasts are available everywhere across the country, DTV sets should be more affordable. In the meantime (and as a permanent alternative), you have the option of purchasing a converter box that can adapt your current television set for digital use. The price of a converter box may drop below \$100 during the transition period to full DTV service.

Why Can't There Be DTV in Addition to the Television System We Now Have?

Congress has determined that the current broadcast television service must eventually convert completely to digital transmissions. In fact, the modern technology of DTV is more efficient than analog TV technology and will allow the same number of stations to broadcast more program material using fewer broadcast airwaves. It would be inefficient, expensive, and wasteful to allocate

airwaves – or spectrum – to operate two sets of TV stations permanently, so broadcast service in only one method of transmission (DTV) is necessary. Electronic equipment manufacturers, cable companies, program providers, and the government are working to ensure that cable is compatible with digital technology.

How Many Programs Can a TV Station Send Simultaneously on One Channel With DTV?

The number of programs a station can send on one digital channel depends on the level of picture resolution desired in each program. Broadcasters currently can send one program per channel over analog. With digital transmission, broadcasters can send four programs in standard definition television (SDTV). This is called "multicasting." However, broadcasters may choose to use nearly the entire digital channel capacity for one HDTV program.

OVERVIEW OF BROADBAND DEPLOYMENT

Broadband is not a technology or a type of service. Broadband is instead a characteristic of a transmission service, defined without regard to a transmission medium or technological platform.

The Federal Communications Commission (FCC) considers any transmission technology capable of supporting bandwidth in excess of 200 kilobits per second (kbps) in the last mile, in both the upstream and downstream directions, as a broadband technology. The FCC chose a 200 kbps standard because it is a sufficient speed to transmit full-motion video and allow an end-user to "change web pages as fast as one can flip through the pages of a book." A service that offers broadband transmission is classified as an "advanced service" by the FCC.

Advanced services are themselves a subset of "high-speed" services, which the FCC defines as having the capability to transmit data at speeds faster than 200 kbps in at least one direction, typically downstream. Dial-up Internet access over standard twisted-pair copper telephone wires is a narrowband connection with a maximum data transfer rate of 56 kbps. In between is integrated services digital network (ISDN), a circuit-switched offering that

provides an increased transmission rate of up to 128 kbps using standard twisted-pair copper telephone wires.

This definition has been refined by the Government Information Technology Agency (GITA) division of the Arizona Department of Commerce to refer to any retail service capable of transmitting data in the last mile at a speed of at least 200 kbps in two direction. Thus, the state's working definition of advanced service in this context is analogous to the FCC's definition of high-speed service.

BROADBAND ACCESS TECHNOLOGIES

High-speed Internet access is available over several different types of technologies, although not all types are available in all areas. Not all technologies provide true broadband capability in both directions today, and none of the broadband technologies available today can reach 100 percent of the potential market for broadband consumers. Broadband Internet access is currently available over four different platforms: cable modem service, digital subscriber lines (DSL), fixed wireless, and satellite. A brief summary is provided below. If additional detail is desired by the reader, a much more extensive overview is provided in the [Appendix](#) of this Plan.

Cable Modems.

Cable operators nationwide have invested more than \$60 billion to transform their closed, one-way systems into hybrid systems consisting of fiber-optic and coaxial lines.⁵² These hybrid fiber-coaxial (HFC) systems increase transmission capacity, reduce noise, and provide paths for clean two-way transmissions. These new networks allow cable operators to provide more than 100 analog video channels, hundreds of digital video and audio channels, Internet access at speeds up to several hundred times faster than dial-up connections, interactive video and games, and telephony.

According to the National Cable and Telecommunications Association (NCTA), upgraded cable systems pass 75 million homes, or about 75 percent of all homes passed by cable. As of June 2002, there were approximately 16.8 million digital cable subscribers, 9.2 million cable modem subscribers, and 2.1 million cable telephony subscribers.

Under optimal conditions, an upgraded cable system can provide downstream data transmission rates of 27 megabits per second (Mbps) and upstream rates of 10 Mbps. In practice, cable systems deliver rates of several hundred kbps to 1.5 Mbps because the cable network is a shared medium. All subscribers in a given area share bandwidth. Though data transfer rates remain considerably faster than dial-up connections, there is a decrease in performance as more subscribers are online. Transfer rates are also affected by the proportion of the cable system's capacity that is devoted to advanced services. Data transmissions are also vulnerable to interference and degradation caused by individual subscribers' equipment and network connection points.

Cable operators must allocate bandwidth based upon the overall system's limitations and the usage needs of people who are online. During periods of peak usage, there may be substantial performance degradation of the system. However, cable operators have improved their abilities to manage bandwidth and are now able to offer tiered bandwidth products. For example, Charter Communications offers three tiers of service. The low-end service provides up to 256 kbps transmission—about 10 times a typical dial-up connection—for \$24.95-\$29.95 a month. The middle tier provides 768 kbps downstream and 512 kbps upstream for \$34.95-\$39.95 a month. The highest tier provides 1 to 1.5 Mbps in both directions for \$49.95-\$75.95 per month. About 10 percent of Charter's cable modem subscribers choose the highest tier, with the rest split about evenly between the other two service tiers.⁵⁴ Tiered pricing is one step cable operators can take to win new customers who would otherwise be discouraged by the high price of one-size-fits-all cable broadband, typically \$45-\$50 a month.

Cable modem service represented about 63 percent of the 14 million high-speed Internet subscribers as of June 2002.

Digital Subscriber Line (or Loop) - DSL

DSL technology transforms an existing copper loop used for voice grade service into a conduit for high-speed data transmission. The wire's higher frequencies are used to transmit data, and the lower frequencies are used for voice and analog fax

transmissions. DSL can function as an Internet connection and telephone line simultaneously. High-speed signals are sent over the upgraded copper loop to a Digital Subscriber Line Access Multiplexer (DSLAM) located at a carrier's central office or a remote terminal. The DSLAM combines the end-user's Internet Protocol (IP) signal with the IP signals of other customers and forwards them onto higher-speed network backbones. A much more detailed primer on DSL is available in [Appendix A](#).

Because it works over existing telephone plant, DSL is significantly less expensive to deploy than HFC cable system upgrades. It is not necessary to upgrade the entire network before service can be sold to customers because subscribers' copper loops are reconditioned individually. Unlike cable modem service, DSL offers dedicated bandwidth, at least to the DSLAM, as the connection is not shared with other users.

DSL technology is not without its limitations. The most significant is signal attenuation, which refers to the dissipation of signal strength as it travels over the copper line. Because higher frequencies are more susceptible to attenuation, the data portion of DSL has distance limitations, which currently range up to 18,000 feet—about 3.4 miles—from the DSLAM. About 80 percent of the country's copper loops lie within this distance of a central office. DSL service is incompatible with bridge taps and load coils, which were installed by telephone companies on portions of their infrastructure to provide improved voice service. Thus, wires fitted with load coils between a customer's premises and the central office will restrict the ability for both the incumbent company and a competitor to offer DSL service to that customer. Thus, not all customers in DSL-upgraded areas may be able to use DSL, also unlike cable modem service.

The largest announced investment in DSL in the U.S. is SBC's Project Pronto, a \$6 billion initiative aimed at providing DSL capability to 80 percent of its customers in its 13-state territory by the end of 2002. Essentially, Project Pronto involves the installation of next generation digital loop carriers (NGDLCs) at remote terminals outside central offices. By pushing fiber into neighborhoods, Project Pronto would in essence overcome DSL's

distance limitation by moving the starting point closer to potential subscribers. However, SBC slowed its investment in Project Pronto in 2001 and 2002, and DSL is today available to just more than half of its access lines.

In rural Arizona, many of the smaller incumbent local exchange carriers (ILECs) have upgraded their networks and begun to offer DSL. Eastex Telephone Cooperative began offering DSL in December 2000, and it is available to more than 85 percent of its customers. Valley Telephone Cooperative offers DSL services to more than 81 percent of its customers throughout its 7,300-square-mile territory. Valor Telecom has committed to providing DSL service within 15 months of a request for at least 75 access lines, and Sprint has deployed DSL to a significant number of its communities.

Fixed Wireless and Satellite

Fixed wireless providers can utilize microwave networks to provide high data transfer rates over the last mile between the consumer's residence or business and the network connection. These systems have the potential to deliver high-speed services to residential, rural, and other underserved areas that wireline services cannot economically serve. Despite great promise, fixed wireless services continue to lag behind wired broadband offerings. Many high-profile fixed wireless experiments have ended without wider deployment, and investment in fixed wireless, at least by larger carriers, has fallen off. A technology overview is provided in [Appendix D](#).

Wireless technologies have several economic advantages over wireline systems. Most notably, there is far less physical infrastructure required to roll out a fixed wireless system, and it can be done on a selective, customer-by-customer basis. Thus, wireless providers can enter a market very quickly with far less investment. However, because the spectrum is limited, there are few licenses in any given area for a given band of spectrum. Furthermore, these licenses can be quite costly. However, technological advances may allow for more efficient use of present spectrum licenses, and thus dramatically reduce the acquisition costs for spectrum. In addition, small providers may be able

to utilize unlicensed spectrum to offer or share broadband connections within a community. Much of the growth in fixed wireless today appears to be in this realm, known as Wi-Fi. Many wireless community networks are configured using this unlicensed spectrum.

Satellites offer virtually unlimited coverage area, and they may be the best means of reaching rural populations and the only means of reaching remote locations. True two-way broadband capability is offered by at least two satellite providers, and satellite systems are available in all U.S. markets. There must be a clear line-of-sight between the consumer's satellite dish and the satellite, which generally means a clear view of the Southern sky. Satellite broadband is typically more costly than wireline products, both in terms of monthly charges and equipment fees. Unlike other broadband technologies, a satellite broadband connection must be professionally installed.

ISDN

Although integrated services digital network (ISDN) technology is not classified as broadband, or even a high-speed service, it nonetheless offers a qualitatively superior Internet connection to traditional dial-up access. ISDN is a digital, circuit-switched service that can integrate voice, data, and video using twisted-pair copper wires and the public telephone network.

As used today, ISDN comes in two standards. Basic Rate Interface (BRI) is the primary residential offering, and it provides data transfer rates of 128 kbps. As such, it does not meet the PUC's threshold for broadband. Primary Rate Interface (PRI), which is actually a standard T-1 line, offers data transfer rates of 1.544 Mbps. PRI is capable of supporting 24 BRI connections, so it can be used by Internet service providers (ISPs) or for private branch exchange (PBX) services. In addition to allowing simultaneous voice and data transmissions, ISDN also provides fast connection times (1 second versus 20 seconds for a dial-up connection) and the capability for videoconferencing.

ISDN requires an end-to-end digital connection along the whole length of the circuit. In 1995, the Legislature began requiring ILECs to upgrade their

networks to digital technology and to deploy ISDN upon request. The rate for BRI was also capped by the Legislature at September 1, 1999, levels until September 1, 2005, for most customers. Despite this cap, ISDN is more expensive than either DSL or cable modem service, and it is expensive to deploy. There is little incentive for ILECs to market ISDN, especially to businesses or governmental entities that would otherwise have to obtain T-1 lines, a far more lucrative service offering. There are likely fewer than 200,000 ISDN access lines in the state, but ISDN is likely capable of a wider deployment than any other land-based high-speed platform. Not all consumers will be able to choose among all these different technologies. More choices between kinds of services or providers are likely to be found in larger metropolitan areas than in rural parts of the state. In a fair number of locations, there may be only one terrestrial high-speed service provider, at least in the near future, with satellite offering a second choice. As mentioned, in some areas, satellite will be the only choice.

NATIONAL BROADBAND DEPLOYMENT

As noted, broadband subscribership continues to show fairly robust growth, especially given the economic downturn over the past 18 months. Much of the available data on broadband adoption comes from the FCC, in the form of its periodic reports on the availability of broadband services, and industry itself, in the form of market reports and financial filings.

FCC Data. Section 706 of the Telecommunications Act of 1996 (“the Act”) directs the FCC and the states to encourage the deployment of advanced telecommunications capability to all Americans on a reasonable and timely basis. It requires the FCC to report periodically on the availability of advanced telecommunications capability and, based on the commission’s findings, to take action to accelerate deployment, if necessary. The FCC issued its Third Report in February 2002.

The FCC concluded that broadband was being deployed “to all Americans in a reasonable and timely manner.” Specifically, the FCC found that subscribers of high-speed services were reported in 78 percent of the Nation’s zip codes, in which 97 percent of the Nation’s population resides. As of

June 2001, there were approximately 7.8 million residential and small business subscribers of high-speed services, which included 4.3 million subscribers of advanced services. This represents an increase of 5 million high-speed subscribers, including 3.3 million more advanced service subscribers, since the end of 1999.

Several groups of consumers could be “vulnerable to not receiving timely deployment” of broadband, the FCC cautioned, including those who are low-income, minorities, rural residents, tribal land residents, or disabled. For example, less than 60 percent of the poorest zip codes had at least one high-speed subscriber, compared with 96 percent of the richest zip codes. Fewer than 37 percent of the most sparsely populated zip codes had at least one high-speed subscriber, compared with 98 percent of the most densely populated zip codes.

According to the FCC’s data, Texas had 33 broadband providers as of June 30, 2001. They served a total of 646,839 high-speed lines, of which just over half were cable modem service lines. Slightly less than half were served by wireline technologies (31 percent for DSL with the rest accounted for by other wireline technologies, such as T-1 lines), and an unspecified percentage were served by satellite and fixed wireless providers. This represents a 324 percent increase in lines served in Texas since the end of 1999, compared to 249 percent for the Nation as a whole, suggesting that Texas has provided significant opportunities and markets for companies to invest in and deploy broadband infrastructure.

The data used by the FCC have three main limitations. First, providers were not required to report the number of subscribers or type of services offered within a zip code. Second, providers were not required to distinguish between business and residential subscribers. Third, the data were aggregated in such a manner that it is impossible to determine whether there is a single provider in a zip code, two providers, or three providers. Thus, there is no distinction between a zip code where three broadband providers serve thousands of residential DSL and cable modem service subscribers and a zip code where a single company serves a single large business subscriber with a single T-1 line.

Industry Data. Broadband deployment and penetration data change rapidly. The data reported by the FCC in its Third Report is from June 2001, eight months before the report was issued. It remains the most comprehensive picture of national broadband deployment. However, significant data is reported by broadband providers in the forms of annual and quarterly reports to the U.S. Securities and Exchange Commission (SEC), and periodic surveys and reports by telecommunications consulting firms offer additional glimpses into more recent subscriber numbers.

Based on this data, it appears that there were around 14.2 million subscribers of high-speed Internet access in the U.S. as of June 30, 2002, which represents about a 64 percent increase in subscribers since June 2001. These estimates do not count subscribers to ISDN or T-1 and higher forms of connectivity.

Cable modem service providers appeared to have about 63 percent of the overall broadband market, and DSL providers had about 35 percent of the market. The market share of satellite and fixed wireless providers is difficult to estimate—specific subscriber numbers are harder to come by—but was probably less than 2 percent. These numbers include both business and residential customers.

The cable numbers may be slightly overstated because some systems included in these totals have some Canadian customers. In addition, because a number for other DSL companies could not be determined, the market share of DSL may be slightly underestimated.

Prices for broadband nationally appear to have leveled off after two years of steady increases. During 2001, the average price of cable modem service rose 12 percent to \$44.22 from \$39.40 per month, and the average price of DSL rose 10 percent to \$51.67 from \$47.18 per month. In the first quarter of 2002, prices continued to rise. The average price of cable modem service rose another 4 percent to \$44.95 per month, and the average price of DSL rose a scant 1 percent to \$51.82 per month. Since the beginning of 2001, 91 percent of broadband providers have raised their prices. In the second quarter of 2002, prices held fairly steady. The average price of cable modem service rose a

scant 1 percent to \$45.31 per month, and the average price of DSL actually fell 1 percent to \$51.36 per month. The same study noted that subscriber growth rates “sunk to their lowest percentage levels on record.” In response, many cable operators and DSL providers have begun to offer tiered pricing, with lower-priced entry level plans, and ratcheted up promotions for new subscribers.

BROADBAND DEPLOYMENT IN ARIZONA.

Need updated "provider-Estimated population without access to broadband" chart

No snowflake in an avalanche
ever feels responsible.

Stanislaus Lezcynski

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TELECOMMUNICATIONS PLANNING

Actions and Policy Considerations

The Telecommunications Plan described herein is in keeping with the Governor's policy and planning guidance, and incorporates a series of action steps necessary to implement a more formal Telecommunications Policy for Northern Arizona. It is designed not to conflict with or supersede plans, policy nor law applicable by either the State of Arizona or any Federal authority. It is intended as a guide to identify and address with good understanding, the issues that inhibit telecommunications growth in rural - or more specifically - Northern Arizona relative to their metropolitan counterparts, and to prescribe specific approaches to overcome those issues. The supporting detail for each set of action steps, and specific requirements and alternatives for implementation are found in the referenced appendices. These action steps will assist communities throughout Northern Arizona in meeting the following prime objectives stemming from its Telecommunications Policy:

Protect and promote enhanced public health, safety and welfare.

Facilitate deployment of advanced telecommunications technology and services in business, residential and government applications. To the extent consistent with Federal and State law, promote competition by creating and maintaining a level playing field for telecommunications system and service providers.

Maintain and enhance a pivotal role in the administration of the public Right-Of-Way (ROW) and community properties, and coordinate

cooperative use of private ROW where it is in the best interest of Northern Arizonans.

Obtain fair and reasonable compensation for use of the ROW and City property(ies).

The policy steps listed below should serve as primary guidelines to addressing telecommunications in all communities in rural Arizona.

COMPLIANCE WITH - AND AFFECT ON - FEDERAL LAWS AND REGULATIONS.

Policy Statement: Northern Arizona supports efforts which advocate the deployment of telecommunications services on a competitively neutral and non-discriminatory basis. In this regard, Communities will apply federal laws and regulations in a fair and impartial manner while continuing to preserve local authority.

Applicable Action Steps:

- Continue to support legislation that encourages the deployment of telecommunications services while, at the same time, retaining local regulatory authority.
- Encourage the delivery of advanced telecom services pursuant to Federal enablements and requirements, to all Northern Arizona Communities including residents, educational institutions, libraries, businesses, government and other organizations.
- Advocate, develop and employ necessary means to receive fair and reasonable compensation for use of public property and the public right-of-way.

- Continue to comply with well-established Federal laws and regulations that affect telecommunications providers Northern Arizona. Where necessary, update this Plan to reflect prevailing Federal law, regulations and Judicial decisions.
- Apply Federal laws and regulations in a competitively neutral and non-discriminatory manner.

COMPLIANCE WITH, AND AFFECT ON, STATE LAWS AND REGULATIONS.

Policy Statement: Northern Arizona Communities will continue to use current enablements given under State law to receive compensation for the use of the ROW, including seeking the recovery of costs incurred related to ROW use by commercial providers. Where necessary and appropriate to change State law to enable Communities to receive more fair, reasonable and equivalent compensation from all users of the ROW, and in so doing help level the playing field and benefit its citizens, Northern Arizona supports efforts that advocate such change to State law. Northern Arizona Communities may work proactively with other local governments and allied entities on initiatives to change State law in this regard.

Applicable Action Steps:

- Continue to use current State enablements that support Northern Arizona efforts regarding proactive management of the ROW, full cost recovery related to ROW management activities and ROW use impact, and regulation of cable television and other video services.
- Continue to work with the other local governments and allied entities to preserve local authority related to ROW use and the use of public property.
- Where beneficial to Northern Arizona Community interests, advocate changes to State law to enhance local authority over ROW users in order to level the playing field, improve the competitive telecommunications climate and receive fair and reasonable compensation for use of the ROW and public property.

ENCOURAGEMENT OF COMPETITION.

Policy Statement: While continuing to appropriately manage the use of the public right-of-way, Northern Arizona Communities will encourage and promote competition in the local telecommunications marketplace. It may use all avenues open to it, to pursue an increase in the number and diversity of telecommunications services available in Northern Arizona, including advocacy of beneficial initiatives at the State and Federal levels. It will make Northern Arizona citizens aware of its efforts to promote competition through public reporting mechanisms, including electronic means such as the Community websites.

Applicable Action Steps:

- Support legislative, regulatory and other initiatives at the State and Federal level that work to open up the telecommunications marketplace to increase competition, while continuing to preserve local authority over the use of the public ROW and public property.
- Work through public private partnerships and other cooperative efforts to enhance the availability of advanced telecommunications infrastructure and services for Northern Arizona residential, business, organizational and institutional entities. This should include working with established groups such as the Greater Flagstaff Economic Council to continue to explore ways to identify and match business needs with current and potential telecommunications infrastructure and service providers for the benefit of Northern Arizona's economic development.
- Develop initiatives at the local level through regulatory and other provisions and agreements that work to increase the availability of advanced telecommunications infrastructure and services Northern Arizona. These initiatives may include: provisions in cable and other video system agreements that foster the rapid development and deployment of advanced services; land use provisions that foster service and infrastructure deployment in new residential developments and business and industrial parks as such areas are first being developed; and other similar initiatives.

PROACTIVE MANAGEMENT OF THE PUBLIC RIGHT-OF-WAY (ROW)

Policy Statement: Northern Arizona Communities will continue to proactively manage the public ROW. As part of this management function, Communities will seek to enhance their permitting provisions and develop a comprehensive set of provisions that apply to all providers, as allowed by State and Federal law. These provisions will include measures to ensure that citizens do not subsidize private infrastructure development, by guaranteeing that Communities are reimbursed for all of the direct and impact costs concerning the use of the ROW by commercial providers.

Applicable Action Steps:

- Continue to use and enforce current beneficial ROW permitting and ROW use agreement provisions, such as: notice of construction requirements; non-transferability clauses; flexibility on establishing specific requirements of the Community projects related to ROW use; the filing of cash or corporate bonds; inspection requirements; and as-built map requirements.
- Review and implement changes to the ROW permitting and ROW use agreement process and provisions, including potential requirements related to joint excavations; longer time frames for repair and restoration responsibilities; the implementation of moratoria on recently repaved streets; shorter time frames on relocation requirements related to public works projects; electronic filing of as-built maps in widely-used and accepted formats; and other beneficial provisions.
- Continue to review ROW permit and use fees and implement changes to ensure full cost recovery related to Community permitting activities and compensation for street life degradation.
- Develop and implement a ROW management committee made up of key staff members from pertinent departments (e.g., City Manager's Office, Public Works, Community Planning and Development, Information Technology, City Attorney's Office, and others) to meet monthly or at some other necessary interval to discuss issues related to current and anticipated activity in the ROW.

- As part of continued GIS system implementation, develop layers related to telecommunications, cable and utility infrastructure placement to assist the City in its ROW management functions.
- Increase the development of electronic information flow, both internally and externally, related to ROW use permit applications processing, status and records information.
- Incorporate all the above, as well as other concepts from the Policy and Plan, into a new, overarching master telecommunications ordinance.

PERSONAL WIRELESS COMMUNICATIONS SERVICES

Policy Statement: Northern Arizona collectively supports and encourages the roll-out of Personal Wireless Service facilities, while at the same time, retaining and enhancing its local zoning authority and its sensitivity to local concerns. Supplementing the existing zoning standards will continue to safeguard the public health, safety and welfare of Northern Arizona residents, continue to treat functionally equivalent telecommunications services in an equitable manner and further manage public property and the public right-of-way which is held in trust for Northern Arizona citizenry.

Applicable Action Steps:

- Continue the review of existing local provisions and regulations in the zoning code and related materials that effect personal wireless services. Supplement, where necessary, current setback, height, rooftop location and equipment screening and camouflage requirements.
- Implement a wireless service provider registration requirement, and inventory existing towers and antennas to determine whether zoning compliance exists and whether all applicable permits and leases have been obtained from personal wireless service providers in the applicable community.
- Review existing leases between the community and providers to identify areas and substantive provisions which could be included in an overall personal wireless services and facilities ordinance. Beneficial provisions, for example, could include current or augmented

requirements related to compensation, technical and siting specifications, indemnification, termination and other provisions.

- Continue to act in a manner that does not unreasonably discriminate among providers of functionally equivalent services.
- Evaluate timeframes currently used to review requests for authorizations to place, construct or modify personal wireless service facilities. Such reviews must be completed within a reasonable period of time after the request is filed, taking into account the nature and scope of the request.
- Further address a number of specific considerations concerning the aesthetics and deployment of towers, antennas, powering equipment and other facilities and equipment.
- Develop and enact an overall personal wireless service facilities ordinance reflecting the results of the above review activities. This ordinance should address a variety of issues, including site selection criteria, preferences for public property, co-location requirements, permit and inspection requirements and non-use/abandonment provisions. Such an ordinance also should indicate that any decision to deny a request to place, construct or modify personal wireless service facilities shall be in writing and supported by substantial evidence contained in a written record.

INTERNAL TELECOMMUNICATIONS SYSTEM DEVELOPMENT

Policy Statement: Northern Arizona Communities will continue to advance and develop their internal telecommunications systems for the benefit of its citizens. Such advancements lead to more efficient government operations, more accessible government services and a more informed citizenry. Communities will use a combination of expanded or improved internal infrastructure, equipment and other resources, as well as continued outsourcing of some support functions, taking into account the best cost versus benefit analysis, to expand their provision of information electronically and heighten video, voice, and data communications connectivity, capacity and capabilities.

Applicable Action Steps:

- Continue to pursue current critical activities related to any upgrade of the Community E-mail system(s).
- Where productivity and responsiveness are essential, upgrade the Community/ City's telephone system(s). This may include considerations for a new PBX system with expanded voicemail capability and/or employing new technology (e.g., Voice over IP) as a means to achieve increased service capabilities and/or reduced cost.
- As competition increases in the local exchange carrier marketplace, review options regularly (at least annually) for the most cost effective provision of dial tone services.
- Upgrade the Community's/City's data communications system. This may include: upgrading routers and some hubs at all pertinent Community/City facilities; upgrading the Ethernet switch at City Hall; subnetting or migrating to higher speed network solutions or higher capability within/between Community/City facilities; and incorporating additional network management and reliability enhancements for the entire network.
- Plan for the migration of City networks to, over time, accommodate multi-media operations of all digital production, post-production and transmission equipment and facilities.
- Expand the connectivity options for multi-media communications to include additional multi-media content origination sites at the designated Community facilities.
- Subscribe to the use of fiber optic and other institutional network infrastructure, provided through network provider agreements to enhance Wide Area Network (WAN) connectivity between the Community/City facilities. For those facilities connected via fiber, this would include a minimum expansion in connection capacity for data communications of between 10 and 100 megabits per second (Mbps) and up to 2 Mbps for facilities not connected by fiber optic cabling. Where feasible and necessary, redundant pathing should be built into the infrastructure in order to enhance network reliability.
- Investigate direct, high capacity access to an Internet Service Provider(s) to eliminate slow

system response and internet access delays, and emphasize Service Level Agreements (SLAs) whenever possible to improve access to, and provision of, reliable web-based services. Concurrently, Northern Arizona communities should upgrade website hardware and software capabilities as needed to increase the services that can be provided electronically. These services should ultimately include, for example, on-line registrations for a variety of community activities (e.g., those sponsored by Parks and Recreation). Community alliances within Northern Arizona should coordinate and share internet-based web-based service developments wherever possible to minimize duplication of efforts.

- Place increased emphasis on development and use of the Community/City's GIS system. This may include devotion of one or more full time resources to GIS system development and maintenance, as well as initiating broader delivery of GIS to critical desktop locations (such as in Public Works).
- Where feasible, investigate enhanced connections to other government agencies and organizations as desired by various Community departments.
- Continue to monitor interest in the use of telecommuting, videoconferencing and tele-training, and employ such technologies as demand increases.

SYNERGIES BETWEEN FLAGSTAFF AND COCONINO COUNTY.

Policy Statement: A synergistic and efficient relationships between the City of Flagstaff and Coconino County can provide a platform for significant and cost effective resource sharing. A joint committee composed of members of the City and County may be established as a means of identifying and implementing services that assist both organizations in a cooperative way.

Applicable Action Steps:

- Continue the synergistic relationship with the County related to 911 and other public safety telecommunications services.
- Carefully examine the telecommunications needs within both organizations, and at each

contract renewal opportunity evaluate the possibilities of consolidating network traffic, management and security. Compete all telecom services.

- Explore ways with the County to increase the capacity of the Internet connectivity.
- Continue the effective relationship between the City and County related to GIS system development, and to improve real-time access to appropriate portions of the databases.
- Continue to explore ways to develop further synergies between City and County functions where costs can be saved or avoided and capabilities can be increased.

MONITORING AND INTEGRATION OF NEW TECHNOLOGIES AND SERVICES

Policy Statement: Continue to monitor the development of new telecommunications technology and services and integrate them where appropriate to increase service levels and operational efficiencies and reduce costs. Encourage the development and deployment of new technologies and services that enhance the competitive service climate for local citizens, businesses, government, and other organizations and institutions.

Applicable Action Steps:

- Continually monitor telecommunications technological trends in cooperation with Greater Flagstaff Economic Council as part of ongoing regional economic development functions to determine their potential application to or impact on internal and external telecommunications environments.
- Actively monitor trends regarding: fiber optics transmission systems and applications; advances in wireless communications system infrastructure and applications; the development of Digital Subscriber Line and similar services for both the home and business marketplaces; the continuing advancement of data-over-cable transmission technology and applications; and the rapidly increasing utility of the Internet for both voice and video, as well as data, communications.

CONTINUED FOCUS ON CITIZEN INPUT, INVOLVEMENT AND INTERESTS

Policy Statement: Continue to inform, involve, serve the interest of, and receive input from citizens in both the implementation of the Telecommunications Policy and Plan, as well as in proceedings concerning future Policy and Plan reviews and changes. Regarding citizen telecommunications needs and interests. Work to advance the availability and diversity of cost effective telecommunications services within the region. Work to provide an increasing amount of government information and services electronically. At the same time, enhance the oversight, to the extent allowed under Federal and State law, of the placement of visible wires and structures consistent with the needs and interests of affected citizens and service providers.

Applicable Action Steps:

- Continue to inform, involve, serve the interest of, and seek input from, regional communities of interest as the GFEC develops and assists with implementation of Telecommunications Policy and Plans.
- On an annual basis, or as required, review the Policy and Plan and seek input from the citizenry on any prospective modifications.
- Specifically regarding the residential community, set as a high priority the creation of a telecommunications services climate that promotes local telephone and broadband service competition, higher speed Internet access, and significant infrastructure oversight that is sensitive to the concerns of citizens regarding visible wires, equipment, housings, towers, antennae, and other infrastructure.
- Specifically regarding the business community, set as a high priority the creation of a telecommunications service climate that reduces the cost of telecommunications services, promotes a variety of avenues for electronic (e) commerce and facilitates a high degree of network reliability through the presence of a number of redundant provider and infrastructure options.
- Continue to evaluate and implement services (informational or transactional) for citizens that can be offered electronically.

2

VISION

What should we aiming for. . .

By 2010, Arizonans should be able to benefit from the use of broadband in the same manner as those living in what are currently classified as the “most wired cities in the world.” Such broadband access will allow them to be healthier, more informed, more educated, and more productive.

Problem? The United States is currently ranked sixth in the world in household broadband deployment. Only 10.4% of households subscribe to high-speed internet service, versus South Korea’s 51.7%, Hong Kong’s 26%, and Canada’s 19.7% (eMarketer, “*Broadband & Dial-Up Access*,” Aug. 2002). A separate OECD report ranks the U.S. as sixth among the OECD countries (which does not include Hong Kong, thus making the U.S. actually at least seventh), and third in rate of deployment among the OECD countries (exceeded by Japan and Canada).

Within the United States, Arizona has been ranked by the Progressive Policy Institute as ninth in broadband deployment over telephone lines; and the FCC ranked Arizona eleventh based upon our rate of increase in broadband deployment during the 2001-2002 timeframe. These statistics reflect first that the U.S. is not even close to being the world’s leader in broadband. And second, that Arizona’s broadband landscape is not worthy of boasting even though 77% of Arizona’s citizens live in the fiber-rich areas of Phoenix and Tucson. Rural Arizonans fare out far worse in terms of broadband availability options and cost.

In 2002, less than half of Arizona’s 87 cities and towns with populations over 500 have access to

broadband services (defined: 200kbps in either direction). This leaves the remaining communities in the pre-1995 economy, with limited access to distance learning, telemedicine, e-government, a less than satisfactory quality of life, and an anti-business environment. Unfortunately, those areas not served, or under-served, by broadband connections often have the highest unemployment and poverty rates. Meaning: those areas to which we need to bring economic development and revitalization the most lack the necessary infrastructure to grow existing, and start/attract new, businesses. Not only are the infrastructure and services not available for the businesses, which drive the local economies, but for the residents, educational facilities, critical services (e.g. police, fire), health institutions and government offices. In some cases, where the infrastructure appears to be available, it is not “affordable,” due to the lack of competition.

ESTABLISHING GOALS

A number of governments have set goals for broadband development. While it might be useful to differentiate business users from residential users in setting goals, most goals seem to put more emphasis on residential rather than business broadband usage. These goals also tend to be more

or less concrete *and* therefore questionable regarding their purpose. Giving signals to the private sector and users on the importance of broadband is important, but mandating specific target dates without justification, especially at such an early stage of broadband development, is not wise.

When goals dictate achievement of being “the most connected” or having the “most competitive broadband market,” there must also be some verifiable “value” to the subscriber.

The rationale behind the goal must be clarified and explained to telecommunications providers as well as users. Although a number of countries set a specific date for broadband completion, the reasons for adopting such timeframes have not been fully explained so far.

Therefore, *government* goals for broadband should focus on ensuring that infrastructure and competition is not hindered in any way by forces other than the marketplace. Care must be taken that government initiatives do not distort market incentives. Aggregation of traffic policies may be the most useful to develop competing infrastructures. In areas where it has become fairly clear that there will be no private investment, or that it may be a long time coming, assistance should be used in such a way as to promote market competition.

The purpose of this document is not to create telecommunications public policy. It is to delineate a path to the future for Northern (or more appropriately, *rural*) Arizonans. State and local governments have lagged in achieving or incenting telecom services development that would adequately spawn demand for broadband services to homes and businesses. The two most prominent reasons for this suppressed demand are high service costs and lack of attractive content. Together, these constitute the “value proposition” as viewed by consumers. As these improve, demand will increase naturally.

The Telecommunications Plan supports the state's vision of widespread access to government services, a single face of government, and increased public/private sector cooperation. This plan is

intended to identify ways to address the following goals over the next one to five years:

- Formulate strategies for proliferation of broadband-capable resources into rural Arizona
- Reduce the cost of telecommunications resources to State and Local government, businesses, and residential users Provide public access to government information and services.
- Establish the platform needed for public access to educational resources.

The plan includes functional requirements for the network infrastructure, addressing the general and specific needs of end users as well as the different and common requirements of the network's diverse member groups of agencies and educational facilities. Also addressed are the needs of local government and school districts-entities that use the network(s) by choice, not mandate, for the benefits of participating in the state infrastructure.

In addition, the Telecommunications Plan highlights the policy issues that will need to be addressed in the upcoming legislative session(s) to overcome barriers to complete a seamless, reliable broadband network implementation.

The state faces challenges in the following areas:

- Rural telecommunications infrastructure and services
- Network self-sustainability
- Private/public sector exchange
- Network address space
- Changes in municipal rights-of way ordinances
- Competition in local services
- Network security
- Homeland security
- Support for intergovernmental agencies
- Disaster Recovery and Operations Center requirements
- Community-of-interest networks
- Renewal of incentive deregulation rates, and
- Continued funding for agencies

Arriving at a single, consolidated state telecommunications network involves three areas of service:

- *Consolidation of the state transmission requirements*—Consolidating the bandwidth, or circuit capacity, needed to carry the data, video, and voice services on a single, statewide backbone.
- *Provision of network connectivity and reliability*—Providing the actual connection(s) from users in various locations to the statewide backbone infrastructure.
- *Centralization of network management and support functions*—Consolidating operational support into a centralized structure to manage the network, provide trouble and ordering support functions, and provide accurate billing and accounting services.

The following issues are typically raised during the planning process:

- Diverse agency needs complicate the process of consolidating all agencies into a single data network. Agency requirements can be grouped into community-of-interest networks. As an example, interests of the criminal justice systems and health and human services areas do not coincide with the needs of the education areas in regards to security, privacy issues, and other requirements.
- There is a large investment in the existing state agency networks, which were - and still are - implemented to meet specific needs. Migration of these networks to a single state network framework should be based on voluntary compliance and occur over several years. This type of transition would enable agencies to plan for future migration issues and allow the state to fully realize previous investments.
- The state infrastructure increasingly supports local government access to the state and national networks (e.g., the Internet), especially to remote regions where there are no other willing service providers. This growth in service compounds the issues regarding diverse interests (e.g., K-12 education on the same network as sensitive criminal justice transactions) and increases the support and management required to operate the network. GITA will need to address these central management and operational issues as the

network continues to expand in serving rural and remote areas.

- The state network cannot currently support non-governmental institutions. This is a factor in providing connectivity for some projects (telemedicine and services to rural areas) and may affect future electronic commerce endeavors.
- Purpose - What key elements is this Plan intended to address?
- Key goals and objectives have been established at the State level under the offices of the Governor, who has designated the Government Information Technology Agency as the organization to address strategy and policy regarding economic improvement in telecommunications for rural Arizonans. The ongoing, yet nascent, Telecommunications Open Partnership for Arizona (TOPAZ) initiative sets specific goals and objectives to address Arizona's ability to compete on a broad scale in the "New Economy."

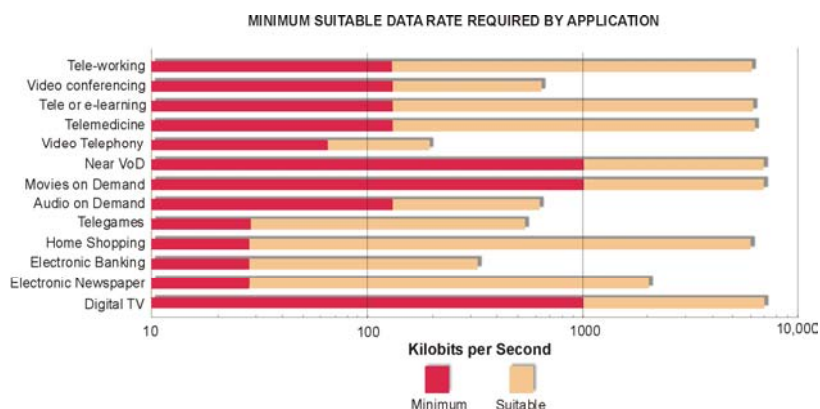
The principal objectives are:

- To **ensure availability** of affordable, high quality, high-speed telecommunications services are readily available throughout the state of Arizona.
- **Remove barriers** and develop market-driven strategies to encourage private-sector expansion of telecommunications infrastructure.
- Where no market-driven solution can be found, identify ways in which communities and the State can "fill-in" the gaps.

The focus of this document is on the availability of so-called "last mile" and "middle mile" technologies. These are defined as follows:

- **LAST-MILE** -- the Internet connection between the end-user and their Internet service provider (ISP).
- **MIDDLE-MILE** -- the Internet connection between the ISP (in a rural community, for example) and an Internet backbone provider (IBP; in Phoenix or Tucson, generally).

FUNCTIONAL BANDWIDTH REQUIRED FOR APPLICATIONS



Source: Planned Approach, Inc.

Dial-up modem = 56kbps max.	xDSL = 128kbps to 1,500kbps (1.5 Mbps)
Cable Modem = 300kbps to 1,500kbps (1.5Mbps)	T1 = 1,500kbps (1.5Mbps); Frame Relay breaks this into multiples channels of 64 Kbps each
Wireless = 128kbps to 11,000kbps (11 Mbps)	Fiber = Up to 40,000,000 kbps (40Gbps) per laser, multiples of [typically] 155 Mbps (OC-3, 12, 48, 192...)

Looking at the above graph, and noting the 56kbps or slower speeds available in Arizona communities without broadband, we can see that members of these communities lack the minimum speeds to take advantage of life-changing applications such as teleworking, e-learning, and most telemedicine.

IF THE BROADBAND IS THERE, WILL IT REALLY MAKE A DIFFERENCE? DO WE HAVE SUCCESS STORIES?

CommSpeed, an ISP based in Prescott Valley, reports that at least 250 teleworkers/home-based business operators have moved to Yavapai County due to the availability of their wireless high-speed services. These new residents reside and make a living in such rural communities as Clarkdale, Camp Verde, Cornville, and Lake Montezuma.

Cardiac Care, a Verde Valley-based medical practice, uses CommSpeed's high speed wireless connections to transfer large files resulting from computerized tomography (CT scan), and magnetic resonance imaging (MRI) tests. Broadband

technology has allowed Cardiac Care to expand from its services from one location in Cottonwood to three in rural Verde Valley.

WHAT PRICE DO OUR COMMUNITIES PAY FOR INSUFFICIENT TELECOM INFRASTRUCTURE?

The foundation of most broadband networks still relies on the central office and interoffice facilities (IOF) of the incumbent local exchange carrier (ILEC), otherwise known as the local telephone company. Where ILECs have diverse infrastructure (e.g., rich fiber resources), many local cable and wireless companies can extend last mile Internet service into the community. There are growing cases, however, where these last mile providers are forced to find a different source for Internet traffic.

Several communities in Arizona exhibit case studies where the lack of telecom infrastructure inhibits growth of the local economy, or has caused the loss of existing businesses. The following are just a few examples:

Safford, Arizona will finally get the middle mile connectivity it needs in early 2003. Other communities are not yet so fortunate. Prior to getting this connectivity, Safford has had at least four inquiries from call centers interested in expanding there. Though call centers might seem unattractive to those in Greater Phoenix or Tucson, they can fill a great need in rural Arizona communities. Unfortunately, due to a well-known lack of telecom infrastructure – the foundation for call center business – the Graham County Chamber has had to stop pursuing all call center opportunities. Graham County, with a population over 35,000, has an unemployment rate that has hovered above 7% for the past several years. These call center opportunities ranged in size from 50 to 200 employees, and had starting wages in excess of \$7.50/hour – whereas the average starting wage in Graham County is currently \$6.14/hour. Call centers of this size will usually occupy anywhere from 5,000 to 40,000 square feet, which would have occupied some existing empty storefronts in Safford, bringing in rental incomes averaging \$10,000/month.

“Community A” an unnamed rural community in Arizona with a population over 15,000 and an unemployment rate consistently above 10%, has also lost company relocation opportunities due to a lack of telecom infrastructure. In one case, a company would have started 200 local citizens at a wage of \$7.50/hour, and increased it to \$8.50/hour after one year. The average starting wage in this county is \$6.42/hour. In this case, the company would have occupied 45,000 square feet of an existing building, bringing in \$18,000/month in lease revenue. The bilingual population of Community A continues to be attractive to many companies. Unfortunately, this labor force strength, which could have been used to draw down the unemployment rate, was left untapped due to the lack of sufficient telecom infrastructure.

Lucero Research, the developer of a real estate office management software application, has created high paying, “New Economy” jobs in the White Mountains. In 2001, Howard Jones, a founder of Lucero, indicated that the lack of available and affordable telecom infrastructure was possibly going to drive his company to move at least a portion of its operations elsewhere. In 2002, Mr. Jones

announced that due to the same problem with telecom infrastructure and service affordability, he was moving part of the Show Low-based operation to Scottsdale. This means a loss of some existing positions, the opportunity cost of lost future expansion, and the loss of 600 to 700 lodging room nights – as Lucero also moves its training conferences to Scottsdale.

“Company B” working on the leading edge of laser-based solutions for the semiconductor and flat-panel display industries, had great difficulty getting broadband options in a metro Phoenix industrial location. As a startup, they had experienced cable-modem access while operating in the owner’s home. Such high-speed access is necessary, as the company transfers large files to/from company operations in Florida and with customers worldwide. When they moved to the new Phoenix location, no cable-modem or DSL service was available – and they settled for ISDN (128kbps). As the company grew, they chose a more upscale airpark location. Like many companies in that airpark, they discovered again there was a lack of wireline (e.g. DSL or cable modem) broadband solutions for business, which had prompted approximately four line-of-sight wireless companies to begin offering service in the area. They are now happy with their choice of a wireless provider.

Other communities, businesses, residents, and government organizations in Arizona have pressing needs, as well. The more time that passes without sufficient infrastructure, the greater the loss of possible economic growth or existing economic activity – as well as lost educational opportunities for residents and operational efficiencies for enterprises.

WHAT IS BEING DONE TODAY?

Numerous companies and organizations are rolling out, or considering roll out of, broadband last mile services. We must give great credit to these companies that are attempting to fill the need and establish working long-term business models. These include companies such as Valley Telecom (southeastern Arizona rural fiber build), CommSpeed (second largest licensed wireless ISP in the U.S. – based in Prescott Valley), CableOne and CableVision (deploying cable modem service in

rural Arizona), Frontier (limited rural DSL deployment), SRP Telecom (use of microwave to connect Apache County), and others. We must further encourage these companies in their efforts, and some specific ways to do so are identified in the initiatives list at the end of this report.

The Arizona Department of Commerce has launched its Community Telecommunications Assessment (CTA) Program. This program has the following two phases:

- **Broadband Technologies Study** – This report, with estimated release date of January 2003, will detail broadband last mile (and possibly middle mile) technologies, costs of deployment, financing mechanisms, and identify Federal, State, and local policy issues that affect their deployment.
- **Community Telecommunications Assessments** – Communities will be applying to the Commerce Department for funding of telecommunications infrastructure inventories, broadband demand assessments/surveys, and technology/business recommendations for broadband deployment.

The Government Information Technology Agency (GITA) is assisting the Commerce Department with the CTA program under its comprehensive Telecommunications Open Partnerships of Arizona (TOPAZ) program. TOPAZ includes the following additional strategies:

Leveraging of State purchasing power via the State carrier services contract (State of Arizona Government is the largest telecom user in Arizona) and its relationships with telecom providers to encourage further deployment of broadband services, and introduce competitive pricing and services throughout Arizona.

Encouraging community-level demand aggregation, and even telecommunications task forces, to engage telecom carriers on local issues, including broadband deployment. The State carrier services contract is being used as a catalyst for this demand aggregation.

Tracking of broadband deployment in Arizona, by community, and further investigating existing infrastructure.

Continued use of the former Telecommunications Policy Office (TPO, which was sunset; GITA said it could shoulder the responsibility) staff position as a Telecommunications Development Manager – creating a single executive branch point of contact for broadband policy and strategy development and implementation.

There are also various programs throughout Arizona, which are increasing the demand for broadband, and can be leveraged to increase deployment. These include the Arizona Telemedicine Program, use of the Federal E-rate program by schools and libraries, the Cox Education Network.

SPECIFIC NEED

There is a need to encourage deployment of the following equipment and services:

- Broadband infrastructure, equipment and services which will serve rural and under-served areas of the State with *last mile* broadband service delivery to businesses, residents, government organizations, etc.
- Broadband equipment, services, and infrastructure builds that will bring sufficient bandwidth from the Internet backbone to rural and under-served areas (*middle mile*). Where some “middle mile” capacity exists, there is also a need to build redundant paths to avoid entire regions of the State from being taken offline (loss of long distance, enhanced services, and Internet) by a single fiber cut (e.g. backhoe) or damaged radio (e.g. lightning strike).

WE UNDERSTAND THE NEED TO INCENT LAST MILE PROVIDERS, BUT WHY THE MIDDLE MILE?

Due to the recent advancements in wireless technology, deployment of broadband networks has become more cost-effective – especially in rural or low-income areas with distributed populations. Cable providers are also considering further deployments in rural communities. For these last-mile providers to deploy their networks and charge reasonable rates, however, they must have access to

sufficient and reasonably priced “*middle mile*” connections – the T1 or higher capacity lines that provide the connection between the communities and the Internet backbone points-of-presence that commonly reside in Phoenix and Tucson. If a common middle mile infrastructure is not available, through which they can procure T1s and above at reasonable rates, they must construct their own middle mile infrastructure. Not only does this increase the financial exposure of the last mile providers, but the cost of which is passed on to end-users – often increasing a residential broadband service price by at least \$15 per month.

WHAT ABOUT REDUNDANCY? HASN'T THAT BECOME AN ISSUE SINCE 9/11?

Indeed, the need for redundancy in the telecommunications system was recognized on 9/11. Telecommunications infrastructure was not an identified target that day, but it was damaged or destroyed at a time when it was most needed. This occurred in major metropolitan areas.

Many of Arizona's rural communities are “fed” by a single route of fiber or microwave radios. Repeatedly, communities and even regions of the State have been “cut off” from the rest of the world due to damage inflicted on these single-point-of-failure routes. In the event of an emergency or disaster, most communities would have no backup system, unless cell/wireless phone companies had built their own parallel network into the community.

The issue of redundancy becomes especially critical when one begins to talk about cyber-terrorism, where the actual infrastructure could become a target. With single routes into communities, it would be quite easy for a terrorist incident to be compounded by additional targeting of the telecom infrastructure.

Unfortunately, redundancy does not provide an immediate return on investment for a carrier. It does provide greater reliability for their network, meaning less downtime, and less money paid out as a penalty for loss of service. There is at least one instance where a community lost the chance to attract a relocating business, due only to the lack of redundant fiber feeding the community. Greater business relocations will certainly increase revenue

over the long term. The larger benefit is enhanced safety and security for all residents and enterprises within a community, which could be measured in fewer lost lives in the event of a disaster, natural or manmade.

WHAT ABOUT USING MUNICIPALLY-OWNED TELECOM UTILITIES TO DEPLOY BROADBAND?

The first reaction of many communities when they reach a peak of frustration with the incumbent provider is to “get into the business themselves.” There are many communities around the country that opted to start and operate their own telecommunications utility. Traditionally, this meant they essentially replaced a privately-owned monopoly, with a publicly-owned monopoly – one that not only built a network, but operated it, and sold services at retail to end-users. Many communities have argued that they enjoy greater services at lower prices, while opponents argue that these utilities are subsidized by tax dollars – putting a drain on the local economy.

A new breed of municipally-owned telecom infrastructure is now developing, though, in which a community or municipality installs and owns the underlying infrastructure, but often allows another entity to operate it, and multiple parties to offer voice, video and data services to the end-users. Proponents say this is the same paradigm as having publicly-owned streets to every home, but allowing anyone to drive on them. As the municipalities own the rights-of-way, it eliminates the age-old arguments with providers about digging up streets. This deployment model is fairly new, but there are communities throughout the United States – such as Provo, Utah, and Grant County, Washington – which are deploying fiber to every home and business.

The biggest advantage of municipally-owned infrastructure is the expected return on investment (ROI) schedule. Traditionally, public utilities (and 30 years ago, telephone companies) work on return on investment schedules of 15 to 20 years. Due to the increased competition in the telecommunications marketplace, and the emphasis on maintaining stock prices, private sector telecom companies generally

invest when they can be assured of an 18 month to 3 year return on investment. The highest bandwidth solutions, such as fiber-to-the-home, are also the most expensive to install. In the current competitive environment, it would be almost impossible to find a private sector company willing to wait 15 to 20 years to recoup their investment in a fiber-to-the-home project.

Nevertheless, whether Arizona communities choose to own their own infrastructure, or rely on the private sector, they will be competing for company and residential locations in the future with communities which have chosen to deploy fiber-to-the-home and business scenarios. This is all the more reason for Arizona to take a proactive stance on broadband deployment. This means identifying and implementing funding mechanisms, and addressing regulatory inhibitors like rights-of-way or unusually high tariffs. These issues must be resolved as a first priority.

RECOMMENDED INITIATIVES

These initiatives are offered as examples to be investigated and considered. The Arizona Telecommunications and Information Council (ATIC) does not endorse any one initiative, but believes this is a starting point for discussion on the topic by Arizona's policy makers.

- An **income tax credit**, based on the equipment purchase price, for businesses or individuals that deploy broadband services to rural and under-served communities. To qualify, such services must be made available to residents and businesses, in addition to government, educational, and other users in the community. The tax credits would have a ceiling amount per year, and be scheduled for sunset review in three years. It is recommended that the Montana (20%) and Idaho (3%) models be closely examined.
- An **income tax credit**, based on equipment purchase and installation price, for businesses that deploy inter-city/town transport services to rural and under-served communities. Such deployments may range from building new microwave point-to-point links, to establishing or expanding a point of presence (POP) on existing fiber, to deployment of aerial or

trenched fiber, to installation of satellite dishes for significant bandwidth backhaul. To qualify, Internet service and transport must be made available to either Internet service providers or end-users in the qualifying community. The tax credits would have a ceiling amount per year, and be scheduled for sunset review in three years.

- An **expedited right-of-way permitting process** for establishment of inter-city/town transport ("middle mile"), including coordination of State and Federal rights-of-way, must be established.
- **Use of existing financing mechanisms**, such as the Commerce and Economic Development Commission and the Greater Arizona Development Authority, should be explored as vehicles to aid in deployment of broadband services and inter-city/town transport in rural and under-served communities. If existing mechanisms are deemed insufficient or inefficient, then new financing mechanisms should be established. This includes the exploration of enhancing municipal bonding capabilities for telecom infrastructure. The Michigan Broadband Development Authority should be closely examined.
- **Expansion of the existing Arizona Universal Service Fund**, so that it may be used to finance deployment of advanced (broadband) services. Georgia's Universal Access Fund (an interim fund) and Texas' Telecommunications Infrastructure Fund (TIF) should be examined as models.
- **Continued and expanded funding of the Arizona Department of Commerce's Community Telecommunications Assessment (CTA) program** – which provides funding for communities to assess their telecom infrastructure and broadband demand, and identify desirable methods to increase broadband deployment.
- **Establishment of a statewide strategic plan for broadband deployment**, with participation from stakeholders throughout Arizona (an Arizona Partnership for the New Economy recommendation).
- **Investigate use of State-owned facilities**, such as microwave towers and rooftops, to enable

private sector broadband deployment to communities.

- **Investigate use of new Federal homeland security dollars** to enable establishment of redundant public networks, as well as broadband deployment (indicated by Federal agencies as necessary for enhanced security operations).
- Encourage **establishment of public/private partnerships** to enable broadband deployment – on either the supply or demand side of the equation.
- Continued support of GITA’s TOPAZ program, and the Telecommunications Development Manager position as a single point of contact in the Executive Branch for broadband policy, strategy and implementation.

Priorities should be based on identification of areas of greatest need, in combination with documented community commitment and demand. Areas considered may include those identified with the most unmet demand through the Community Telecommunications Assessment (CTA) program, and those currently classified as Enterprise Zones. All Enterprise Zones have higher-than-average poverty and unemployment rates.

The recommendations listed above will be addressed further in this plan in the following chapters.

REQUIREMENTS OVERVIEW

Fundamental network capabilities to support residents ...

In order to fully grasp the total impact imposed upon rural Arizonans, it is worth reviewing the findings from a Telecommunications Assessment conducted in 2002, and see how it affects the overall region in Northern Arizona. This chapter will take a “personalized” look at users to demonstrate how lack of telecom resources affect virtually every aspect of the lives of people living in these communities.

OVERVIEW OF TELECOMMUNICATIONS CAPABILITIES

This paragraph discusses the general availability of telecommunications infrastructure serving key areas pertinent to this Plan. Capabilities specific to individual communities are addressed individually.

INTER-CITY TRANSPORT CAPABILITIES

In this report, the term “transport” refers to the telecommunications infrastructure network that provides the connectivity to a community. It is also referred to as the “middle mile” or “Wide Area Network. (WAN) Transport.” It is different from “local access”, which refers to the local community telecommunications infrastructure that links individual (homes and business) users to the *transport* network.

Transport facilities provided over copper cable are not viewed as suitable transport to support broadband connectivity except to communities of a few hundred residents or less. Thus, there are two basic categories of insufficiency of transport: [i]

lack of existing capacity on digital radio facilities; and [ii] insufficient transport capability of copper cable transport facilities.

Communities in Northern Arizona with the exception of Flagstaff and the Navajo Nation face a significant shortage of transport capacity. Most of the shortage in transport capacity can be traced to 1) past attempts by Qwest Communications to divest itself of rural exchanges in Arizona, and 2) lack of willing competitors to lay new infrastructure to support these communities because of the high cost to do so. In the interim infrastructure expansions has not kept pace with demand.

The main impact in the surveyed communities is on the transport infrastructure linking the communities of Page, and Williams with the telecommunications backbone. In addition, points East of Flagstaff (e.g., Winslow and Holbrook) lack transport capabilities to marry up with facilities in Holbrook to support the White Mountain area (Frontier Communications) and also provide connectivity into the Navajo Nation.

Interviews with Qwest initially indicated that an aggressive construction program to expand capacity was planned, but that this program has subsequently been shelved because of financial difficulties. The prognosis is that transport capacity relief in these areas will be years away if ever.

In addition, regulatory restrictions apply to a Local Access and Transport Area (LATA) structure that prevent an incumbent local exchange carrier (ILEC), such as Qwest, from using the long haul facilities

of an affiliate company that cross LATA boundaries to relieve transport deficiencies within a LATA.

The following table identifies the applicable LATA of the surveyed communities:

LATA of Surveyed Communities

LATA	Name	Surveyed Communities within LATA
666	Phoenix	Flagstaff, Page, Williams, Hopi Reservation
980	Arizona Navajo Reservation	Navajo Reservation (Arizona)

There are two major transport corridors traversing the State of Arizona that contain fiber optics infrastructure owned and operated by national long haul telecommunications companies. These are installations along I-10 and the railway line operated by UPRR (Union Pacific Railroad) in the south and along I-40 in the north. The preponderance of these facilities is installed along the southern route and only AT&T Long Lines has installed fiber optics facilities along the northern route, I-40, with break-outs in Holbrook and Flagstaff. The AT&T facilities are the only existing potential source of relief to the transport constraint of the surveyed communities in the northern part of the State. However, the AT&T facilities in Holbrook are completely used up, and AT&T indicates that there are no plans for expansion.

The impact of insufficient transport capability goes far beyond the ability of the incumbent service provider to deliver services. It also either restricts or denies the opportunity for the introduction of services by competing service providers. One good

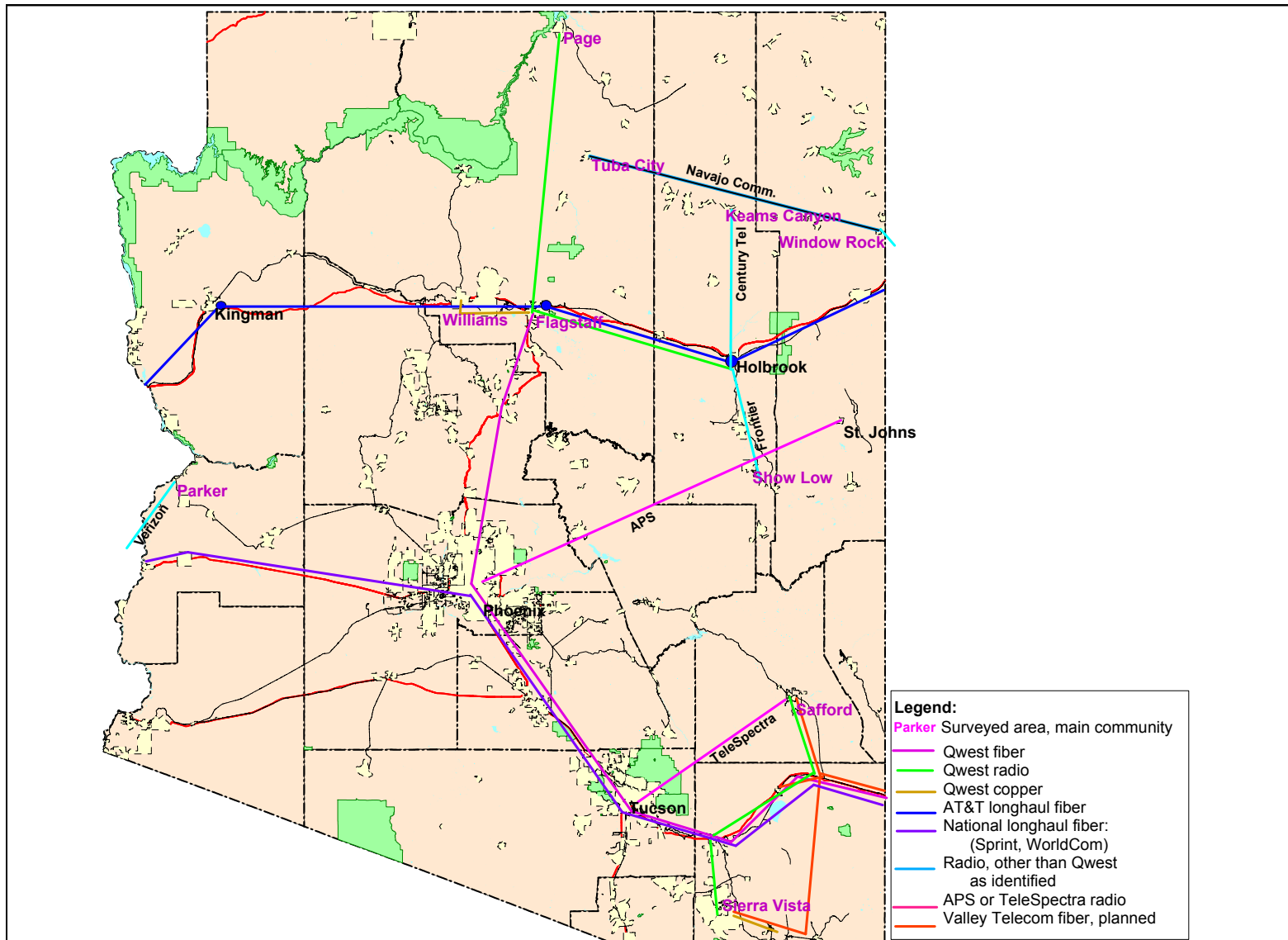
example of this impact is the roll-out of cable modem services by Cable ONE in the Safford area, which is being delayed in Safford, Thatcher and Pima until transport to the Internet backbone is available. Interviews with local Internet service providers there also identified a frustration with the inability to expand and introduce value added services because of lack of transport capacity.

Other infrastructure owners and operators such as TeleSpectra and Valley Telecomm are installing facilities to serve several of the surveyed communities, primarily in the Sierra Vista and Safford areas. These operators may provide a key potential source of transport relief for these communities, however, the needed transport infrastructure is not yet in place.

Other potential transport alternatives that might add relief, such as power companies. The challenge is that the fiber infrastructure these companies own do not generally route to communities that need access to them, and options to provide links from their terminal stations to the communities would need to be assessed and business cases made before any provider would entertain provisioning them.

Virtually all communities in Northern Arizona lack redundant transport facilities (i.e., an alternative route for transporting voice, video, and data signals), and several have experienced lengthy outages over the past few years when the main link to the community was severed. This happened for a second time on January 9th, 2003. Besides the general telephony chaos it creates, some discussions with businesses in Flagstaff indicate that the impact to the total Northern Arizona region could easily have reached into many millions of dollars of lost revenues. The following diagram shows a map of the transport infrastructure serving the surveyed communities.

Inter-City Transport Capabilities Affecting The Surveyed Communities



LOCAL DISTRIBUTION

The primary local distribution infrastructure in all communities is copper based. Flagstaff, Sierra Vista and Safford have several dedicated fiber optic cable runs to major users. These are shown on the detailed maps contained on the accompanying CD.

Qwest's attempts to divest itself of [at least some of] the rural exchanges in Arizona also affects the availability of local access facilities. In most communities, such as Sierra Vista, alternate access routing is generally not available. The Some compensation has been made, but with very long lead times. In Safford, Thatcher and Pima the situation, though, is more severe. In some communities, the copper distribution plant is exhausted to the point where additions to existing telephone services reportedly result in lead times of 12 months or more. This situation also impacts the provision of any form of digital connectivity, since T1 service is commonly reliant on the availability of copper pairs to the end-user. Discussions with the ACC established that the State regulator monitors and enforces the provision of basic services, which cover a single residential telephone line and the first telephone line for a business, and that the organization has no jurisdiction to require the provision of additional services on a timely basis.

This double impact of insufficient transport facilities and local distribution plant can negatively affect the economic development of a region. Discussions with community stakeholders indicate this as a major setback which has resulted in businesses opting to locate elsewhere as a result of telecommunications deficiencies.

HIGH-SPEED ACCESS (BROADBAND SERVICES)

Some communities with the exception of Page, Williams, and the Hopi Tribe have some form of wired high-speed access available or planned.

The wire line high speed access services (i.e., cable or DSL) usually serve the core areas of a community, where distribution plant allows. Other areas of the community may be served by entrepreneurial wireless service providers. Most of

them operate in the unlicensed 2.4 GHz band and a proliferation of several providers in one area can lead to interference unless a designated agent is tasked with managing channel assignments.

Some communities have taken different approaches to deal with this interference problem. For instance, in Graham County (Safford, Thatcher and Pima) a co-operative group was formed to allocate specific channels within the 12 channel range of 2.4GHz to each provider. Other areas, such as the White Mountain region (Show Low, Pinetop-Lakeside, Taylor and Snowflake) essentially manage the introduction of new wireless entrants by controlling access to municipal right-of-way and county owned towers. Larger wireless service providers, such as Cybertrails and CommSpeed take an engineered approach to minimize interference and use licensed and unlicensed spectrum as suitable.

Flagstaff

ADSL and cable modem services are offered within the limitations imposed by the technologies. This, nonetheless, leaves some portion of the community unserved by wired broadband access.

Williams and Page

No ADSL or cable modem service is available at present or planned. Orders for new T-1 services requiring connection to the telecommunications backbone can experience significant delays pending the availability of transport capacity.

Hopi Tribe

Neither ADSL nor cable modem services are offered. Limited private network support broadband (i.e., the telemedicine net), but residences and business do not have general access to broadband capable trunks.

Navajo Nation

ADSL is offered in the main exchanges run by Navajo Communications to a limited number of residents within reach of the Window Rock CO. Cable modem service is not available.

COMMUNITY SPECIFIC SUMMARIES

FLAGSTAFF

Overview

The City of Flagstaff is located in northern Arizona and has a nominal population of about 60,000 with a summer seasonal increase of about 15,000. Its population, location, and amenities make it the regional center, with strong economic links to smaller neighboring communities and to Phoenix about 150 miles to the south. Flagstaff is the county seat for Coconino County, which with over 12 million acres, is the second largest county in the contiguous 48 states.

Flagstaff is a major junction point for travelers to the Grand Canyon and with a major highway link to

Albuquerque, New Mexico to the east and Nevada and California to the west. The Burlington Northern Santa Fee railway corridor runs through the center of the downtown district, and Route 66 is still clearly evident in the city. The City is home for the Northern Arizona University, the largest single employer in the city, and the main campus of Coconino Community College. The City's economy is bolstered by tourism which is the largest sectoral employer in the region.

Flagstaff is seen as an attractive location from a lifestyle perspective to live and to work. An economic goal for Flagstaff is to raise the per capita income through a focus on growing and attracting higher income jobs to the area. Telecommunications is viewed as an essential component of a successful economic growth plan.

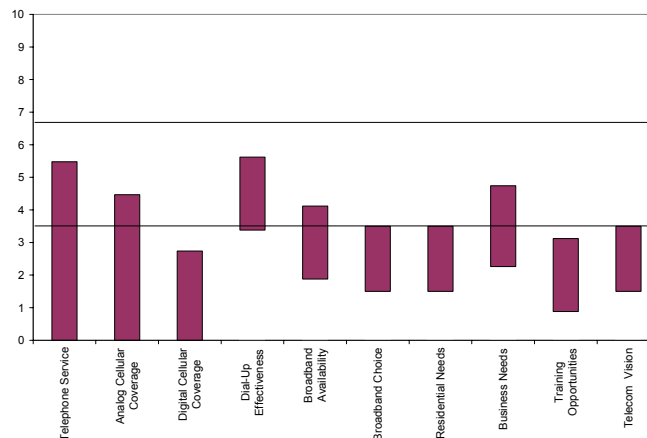
The following table identifies the major telecommunications providers in Flagstaff.

SERVICE	PROVIDER
Basic Telephone Service	Qwest
Cellular Telecommunications	Cellular One, ATT, Verizon, Sprint, Qwest, et. al.
Digital Subscriber Line Service	Qwest and Re-sellers
Cable Modem Service	Flagstaff Cablevision
Wireless Internet Service	InfoMagic, RediLynx (Niles Radio), Safe Access, CommSpeed
Broadband Data Services	Qwest, AT&T, WorldCom, Sprint

Issues

An "Issues Survey" was completed for a sample of approximately a half dozen contacts within Flagstaff. The results of that survey are shown in the table below.

Survey respondents generally paint a dismal picture for basic telephone, cellular, and broadband communications in Flagstaff. The only telecommunications service that ranks as even adequate is dial-up Internet access.



Note 1: Survey results show the mean results for Flagstaff ± one standard deviation.

The results are based on a very small sample size, and in many cases do not appear to reflect the reality of telecommunications offerings in the area (based on consultations with local telecommunications users and providers). For example, it is expected that DSL and cable modem service is available to well over half of the local population. Based on this observation, it is suggested that the City of Flagstaff may wish to use the survey at a future time to secure a larger and more representative sample of views to help direct its telecommunications development initiatives.

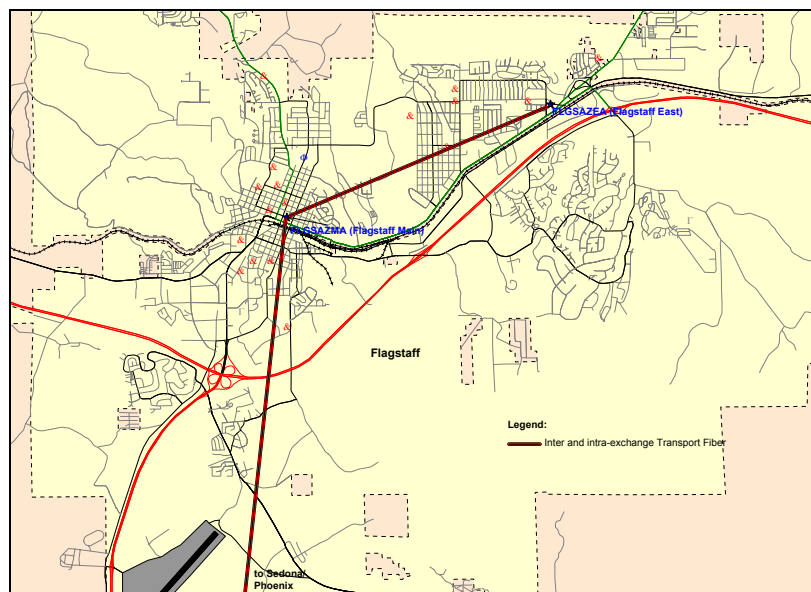
Capabilities

Flagstaff is located in the Phoenix LATA, Nr. 666. The exchange of Flagstaff is owned and operated by Qwest. It contains the wire centers (central offices) of:

- Flagstaff Main; and
- Flagstaff East.

The exchange of Flagstaff was not included in the list of rural exchanges planned to be divested by Qwest, and consequently did not experience the same degree of impact from limited funding supporting transport and local distribution infrastructure as other rural exchanges.

Flagstaff Exchange



The exchange of Flagstaff serves as the major hub to other Qwest exchanges and to other ILEC's in Northern Arizona. Most of these experience major constraints with transport facilities, as explained in the individual community sections within this report.

Transport

Transport into the Flagstaff exchange is provided over a fiber optic cable facility linking to the telecommunications backbone in Phoenix. Qwest did not confirm any user reports of transport capacity shortages. But they do not refute the lack of redundancy.

Qwest's facilities between Phoenix and Flagstaff are on a single route; i.e., there is no grid diversity to provide redundancy in the event of a failure on that route. A cut of the fiber optics cable near Sedona in 2001, and again in January of 2003, resulted in lengthy outages affecting the Flagstaff exchange as well as other communities in Northern Arizona that are downstream of Flagstaff.

AT&T Long Lines has a presence in Flagstaff connecting to its national fiber optic facilities along I-40, crossing the State.

The Burlington Northern and Santa Fe Railway Company (BNSF) is planning to install a radio

system along its rail line crossing Flagstaff. The eastern leg will only be completed to Winslow by the end of 2003. The western segment (from Los Angeles to Winslow) has not yet been funded, and may not be completed before late 2004 or 2005. BNSF indicates that they are planning to lease bandwidth to unregulated service providers along the route, but confirmed that there are no carrier fiber optic cable installations along its railway line in Arizona.

Local Access

The local distribution plant operated by Qwest is primarily copper based. However, there are also over forty dedicated fiber optic cable runs throughout Flagstaff. There does not appear to be any shortage of local distribution plant in Flagstaff, but DSL is still provisioned at the two COs, and to reach outer neighborhoods, additional DSLAMS need to be moved to the city fringes.

Three local wireless Internet access providers operating in Flagstaff were identified. Their services are mostly concentrated on those areas not covered

by Qwest's ADSL offerings or acceptably met by Cablevision's cable modem services.

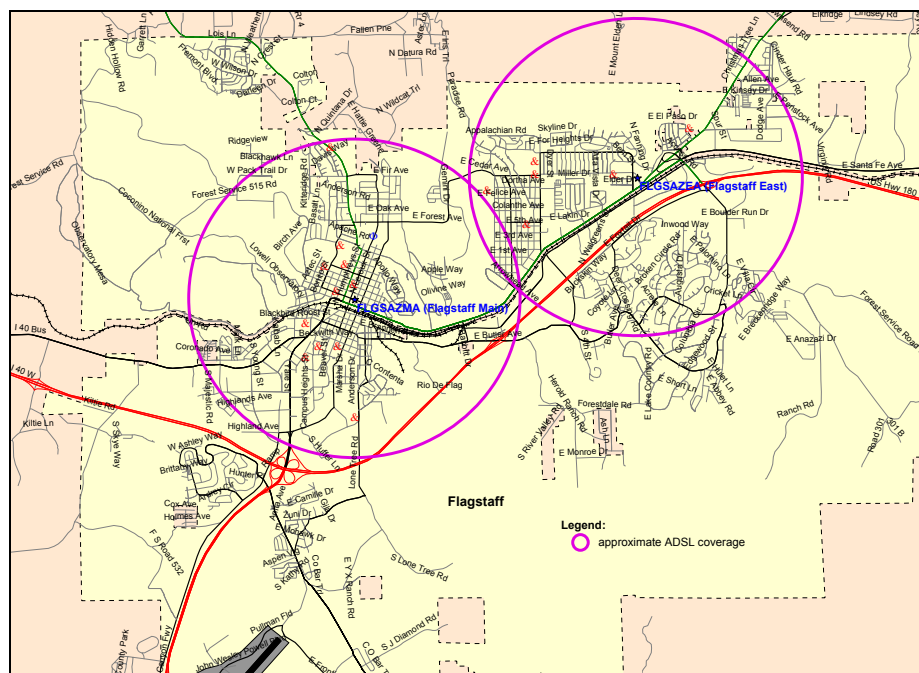
Services

Flagstaff is relatively well-served with high-speed Internet services, as well as with ATM and frame relay services, in some areas. From Qwest's perspective, lead times for new orders are within the norm.

Qwest is offering ADSL service from its wire centers of Flagstaff Main and Flagstaff East within the nominal limitation of 18,000 loop feet from a wire center. The circles in the diagram below estimate ADSL coverage based on 18,000 loop feet distance from a wire center.

Flagstaff Cablevision has upgraded its network to the standard necessary to support cable modem services and is offering cable modem services in those areas covered by its network. It currently has no plans to adopt DOCSIS 2.0 capabilities to offer telephony. A similar depiction of Cablevision's network showing coverage by cable modem service is not available.

Flagstaff Exchange ADSL Coverage



Wireless service providers (e.g. Niles Radio) are extending broadband services to the fringe areas within the exchange that are beyond the reach of the

existing ADSL and cable modem coverage. CommSpeed, located in Prescott Valley, is planning to enter the Flagstaff market in 2003 with its

wireless broadband access service. Funding has been obtained, and plans are moving forward.

Internet Access Service Pricing

Qwest's ADSL service is currently offered at \$49.95/month.

Residential cable modem service is offered at \$34.95/month to existing cable television customers and \$44.95 to those which are not cable television customers. An additional \$10 is added if the modem is leased from CableVision.

Wireless Internet access is priced according to the access speed. According to RediLynx (Niles Radio), the predominant wireless provider, the average access is 512 Kbps downstream priced at \$70/month with an equipment purchase of \$579 and a setup fee of \$180. RediLynx provides an "economy" service to a limited number of customers – 128 Kbps downstream at \$29.95/month with rental customer premise equipment. The current customer base is less than 100.

There is general feeling that these rates were unaffordable and higher than found elsewhere. However, these rates (DSL and cable modem) are similar to other larger and smaller communities in Arizona.

NEEDS

A general theme expressed by stakeholders interviewed in GADA's Pilot Study indicates that there is a need for a higher availability of high-speed Internet access services in the Flagstaff area. The costs of service was also a sore issue to stakeholders. More specifically, although it may appear that high-speed Internet service is available throughout Flagstaff, in reality there are areas where neither DSL nor cable modem service is available, and an estimated 20-30% of households may not have access to wire line broadband services.

In areas where high-speed Internet services are not available, dial-up connectivity is reported as poor quality. The acquisition and analysis of data regarding the copper infrastructure in the Flagstaff area required to assess the extent of the coverage of high-speed Internet connectivity and transmission quality would require the complete cooperation of

Qwest and the cable operator to share "plant cleanliness" analysis data. The Department of Commerce may wish to have this issue addressed in future Phases of its Community Telecommunications Assessment Program.

A further need that acts as a barrier in Flagstaff and other communities that want to attract or grow businesses is the lack of diverse transport infrastructure to Phoenix. Instances of failures on the single fiber optic transport system in 2001 and January, 2003 resulted in the total outage of all communications with Flagstaff and other parts of Northern Arizona. since there is no redundancy, Qwest and any other providers operating in Flagstaff or beyond will not entertain any Service Level Agreement discussions. As a result, any revenue losses resulting from telecommunications outages cannot be mitigated.

Examples of this service outage vulnerability are found at Infomagic's Web site:

"2 August 2001 The outages today from 8am - 1pm and from 4:30pm - 5:45pm were due to a cut fiber somewhere near Sedona. This fiber carries most of the traffic for the Internet in Northern Arizona as well as most Cell Phone service. Qwest spliced the fiber this morning and that "temporary" splice broke later in the day. A permanent repair is planned for sometime after 10pm Thursday." <http://www.infomagic.net> .

A redundant link is viewed as one of the highest priorities both to businesses retention and expansion, and new business attraction - since businesses are becoming more and more dependent on telecommunications to attract new businesses to the area.

Residences

Residents in Flagstaff have a number of competitive alternatives for dial-up Internet access and high-speed Internet through ISPs such as, for example, Cybertrails, InfoMagic and The River. Some concerns were voiced relating to the quality of dial-up Internet services, particularly regarding dial up speeds using a 56 kbps modem. The extent and severity of this service quality cannot be determined without ILEC cooperation.

Digital Subscriber Line services provide a high-speed alternative for those customers living within either of Qwest's DSL provisioning zones in the area – the Flagstaff Central Office and the Eastside Central Office. ADSL, the common technology used by the telephone companies to provide high-speed Internet service, is typically limited to copper loop lengths up to 18,000 feet if they are “clean.” These distances may be substantially shorter if individual line noise is high in order to achieve equivalent data rates.

The specific demographics of the distribution of loop lengths for Flagstaff and area are not available to the public. However, a study by the Pinkham Group covering Arizona indicates that there are approximately 24% of households served by DSL equipped central offices of the RBOCs that are beyond the reach of acceptable DSL service.⁵ Generally speaking, this is a smaller percentage than the approximately 30% that applies for all US households⁶, from which one could conclude that a significant number of households – perhaps 25%-30% of the total - in Flagstaff and area - do not have access to DSL service. This broad estimate is consistent with those presented above, and confirmed in discussions with providers and ISPs.

A number of key stakeholders that were interviewed, including a major ISP, stated that the outside plant facilities (copper loops) in certain areas of Flagstaff are of poor quality (e.g., bridge taps, multiple splices, noisy) and that this significantly limits the effective coverage for DSL service, even within the nominal 18,000 copper loop reach.

Further information on the availability of DSL service to households in Flagstaff, and views on the price of the service, is expected to be derived from residential surveys that may be conducted as part of a future ADOC Community Telecom Assessment grant.

Flagstaff Cablevision provides cable television service throughout Flagstaff and also provides high-speed Internet service using cable modems. Details on the coverage footprint of the cable plant were not made available. Without provider data on coverage within the community, the total extent to which broadband access might be made available has been obtained from other sources. CableVision's HFC network is extensive, with significant additional fiber that traverses the City that they are willing to make available under lease arrangements. They are generally unwilling to provision or operate these leased resources.

There were multiple broadband wireless service providers operating in Flagstaff, the largest of which is RediLynx (Niles Radio Communications). Discussions suggest that that RediLynx and SafeStream (Safe Access) are the two remaining wireless ISP providers. The wireless ISP market in Flagstaff is a niche market with only a few hundred customers as of September 2002.

Businesses

The City of Flagstaff is aware of the shortage of water in the area and the limitation that this imposes on the types of businesses that could locate in the area. Since the manufacturing sector is constrained by the availability of water, the technology and services industries are priority targets for economic expansion in the area. These industries demand the availability of quality, high-speed connectivity provided at affordable prices.

Although T1 service is generally available across most of Flagstaff from Qwest, AT&T, and a few other competitive providers, there are outlying areas where it has been difficult to get T1 service, and businesses in general are not satisfied with the response time to have T1 service delivered or transferred coincident with a move of business locations. A number of sources indicated that there appears to be a disconnect between Qwest and the business community regarding the needs of business and the planning of Qwest's expansions.⁷

⁵ Source: *Broadband Market Survey - DSL Availability of Incumbent Telcos - Q4 2000*, Pinkham Group

⁶ Source: Pinkham Group Web site - <http://www.pinkhamgroup.com/creports.htm>

⁷ An example is the dialog at a meeting with Qwest and the business community called by GFEC on July 10, 2002.

In-person consultations were held with a half dozen businesses operating as independent entities or as part of larger chains. The comments from some of these businesses relating to telecommunications capabilities available to them were as follows:

A small electronic commerce firm located in the suburbs of Flagstaff indicates that it is well-satisfied with existing services and options. It did indicate frustrations over the time required to install T1 connectivity, estimated at over 100 days. No concerns were voiced over uptimes, customer service, or price.

A large manufacturing firm outside the core of Flagstaff has been served by a wireless provider. Service was reportedly down an average of 10%-20% of the time. No alternative broadband providers were reportedly offering service in the area, and the manufacturer has decided to move locations as a result.⁸

A large e-commerce firm indicated that provisioning a T1 connection within the core of Flagstaff took approximately four months of elapsed time between ordering and service availability, and extensive time acknowledging and correcting problems. No other concerns were voiced, though the time to secure T1 connectivity reportedly had significant costs.

A large multi-location manufacturing firm purchases significant bandwidth from a broadband provider. The manufacturing firm was reportedly given only one week to sign a long term contract extension at existing rates or face a significant increase in rates. Customer service and treatment challenges such as these are reportedly the norm.

Note that these discussions do not constitute broad coverage of Flagstaff's business community. Greater insights on unmet needs need to be gathered on a regular basis, starting initially with the survey mentioned earlier.

Public Agencies

⁸ These service down times have reportedly had significant effects on operations, including staff down-time and customer migration. As a result, the firm is moving its operations to an area of Flagstaff with other broadband options.

- CITY OF FLAGSTAFF

The City of Flagstaff has built [partially] its own local telecommunications network that is augmented with circuits from Qwest. The City has a fiber "campus network" and a wireless network with a number of T1 circuits leased from Qwest to interconnect all City offices and locations to the central hub at City Hall. Internet interconnection is provided over a wireless link to NAU. The City's telecommunications needs appear to be well met with the private network in place today.

- FLAGSTAFF CITY – COCONINO COUNTY PUBLIC LIBRARY

The library is linked by fiber to City Hall, but this connection is used for administrative applications only. Internet connectivity is provided by NAU via a frame relay PVC (service from Qwest is called IPVC⁹). They get a 60% rebate through E-rate. The library could get Internet access through the City via the fiber link, but bandwidth impacts led to implementing a separate connection. The new branch East Flagstaff Community Library located on the Coconino Community College 4th street campus is to be connected to the Main library via a point to point T1 from Qwest. The library considers the service from Qwest as reliable, though no Service Level Agreement is in place. Qwest reportedly has difficulties with initial setups, but there are few failures, and Qwest will call before the library is even aware of a problem. The East Library is beginning to experience bandwidth problems, however, and would like to pursue higher bandwidth alternatives that are affordable and preferably eligible for the E-rate discount.

Before the library's future telecommunications needs can be determined the basic question needs to be answered – "What is the role of the libraries in the future?" They do see a need for additional bandwidth and [preferably] lower costs. The library

⁹ Qwest ATM/FR Interworking PVC (IPVC) - Qwest IPVC creates a connection between the ATM network and Frame Relay network. ATM to Frame Relay interworking is an option that allows customers to complement the high bandwidth transport capabilities of ATM with the cost-effective, narrowband data transport of frame relay in order to provide a seamless transition to a single, multiservice network.

notes that approximately 50% of users are in the low income category and the library provides their only means of accessing the Internet.

- COCONINO COUNTY

Coconino County has its own telecommunications network that is administered by the IS department in Flagstaff. The County leased dark fiber from Flagstaff CableVision to connect various County buildings in the central area of Flagstaff. A number of County offices outside of the fiber ring are connected to the central location using T1s provided by Qwest under a special arrangement whereby the County paid a capital contribution to Qwest to install terminal equipment at the County office and in return the County enjoys a reduced flat rate for T1 connectivity throughout Flagstaff. Recent 802.11 wireless links add to their net.

The Burlington Northern Santa Fee Railway will not permit track crossings without substantial license fees, so the County has installed a pair of 100 Meg microwave radios to the LEIF (jail and juvenile probation center) on the south side of the tracks. The County also uses a number of copper “alarm” circuits (LADAs) obtained from Qwest equipped with County-provided FlowPoint routers to connect some of the offices.

The County has a Lucent/Orinoco spread spectrum wireless setup with a wireless link to Infomagic (located at the Monte Vista Hotel), who provide the Internet service to 300 terminals (600 accounts) via an omni-directional antenna at the County location.

The Sheriff’s department office at Page is connected to the Flagstaff office via a T1 leased from Qwest. There is a leased T1 to Williams, Fredonia, and Colorado City (actually in Mohave County, but is administered by Coconino County) will VPN connect to Flagstaff via an Internet dial-up account with the local ISP.

The County plans to administer it’s responsibilities from one central dispatch system. This is expected to be in place within 5 years. The plan includes extending video conferencing and VOIP to all outlying areas and to add T1 circuits to support this. Video conferencing will support health care training (reduce travel) and distance arraignment. A

minimum of 25 frames per second is mandated for distance arraignment and to support this on the Polycom IP video conferencing equipment that is in use requires broadband connectivity with higher speed than that supported with ISDN circuits. The County indicated that it would be prepared to extend connectivity to pseudo-County agencies, but not to private sector or residential users.

Two major barriers to broadband connectivity identified by the County are lack of fiber access to Williams and Page, and overcoming rights-of-way to cross the Navajo nation. Price is definitely not an issue since their prices through arrangements with Qwest are extremely low. This may not turn out to be the case in the future for T1 circuits to outlying areas to support video conferencing.

The County reported that T1s from Qwest are quite reliable, however dealing with Qwest to get connections can be challenging. It is obvious to the County that there has been a significant reductions in funding infrastructure for the region. County representatives are beginning to receive “business case” resistance from Qwest before they will agree to spend capital to provision new circuits.

Northern Arizona University (NAU)

Northern Arizona University is both a user of telecommunications connectivity and a service provider of connectivity for the education sector within Arizona for distance learning and Internet access.

There are two networks provided under the auspices of NAU and Arizona University – the NAU Internet and NAUNet. The latter is predominantly a video conferencing network, but it has some limited data connectivity capability as well.

NAU Internet

Since 1990 the NAU Internet has been extending Internet access to community colleges, K-12 schools, non-profit entities, government entities, cities and counties.¹⁰

As an Internet service provider, NAU Internet has dual-homed Internet access, a DS-3 with AT&T (25

¹⁰ See <http://aspin.asu.edu/about/mission.html> for the mission statement for ASPIN.

Meg) and an OC-3 from Qwest (25 Meg) and a separate connection to Internet II via a 25 Meg circuit on the Qwest OC-3 ATM. There are approximately 40 sites in the state that connect to the NAU Internet using Qwest IPVC circuits. A network diagram is available at http://www.tel.nau.edu/network/topology/Internet20002_frame.htm.

NAUNet

“Northern Arizona University is charged by the Arizona Board of Regents to deliver quality upper-division courses and undergraduate programs to rural and, where specifically authorized, metropolitan counties, and to provide graduate education programs throughout the state. NAUNet serves as the tool to help carry out this statewide charge. NAUNet is a cost-effective way to deliver quality instruction from the residential campus in Flagstaff to sites throughout the state. At some sites, NAUNet supplements instruction delivered by on-site faculty. At other sites, NAUNet is the primary means by which instruction is delivered.” “With 34 active sites, NAUNet is the only network in Arizona linking public education and state agency facilities to one another and to many of the state's C-band and Ku-band satellite up-link services, and providing direct links to most of Arizona's major television broadcasting stations and several cable companies.”¹¹

The NAUNet is an analog network that is designed to carry high quality video conferencing sessions. The analog microwave radio equipment for the network has been provided by NAUNet and the network is operated for NAUNet by Telespectra. Digital capacity has been obtained over the analog network using T1 modems. The plan is to move to a digital service, but there are issues of the trade-off of delay and bandwidth to maintain the current video quality. At this point, the NAUNet group thinks that it needs 45 Mbps bandwidth to maintain the current and expected quality of the videoconferencing network – “studio quality”. This will be totally uneconomic and they are expecting that recent compression algorithms and codecs will provide a service quality that will become accepted as the standard. Telespectra is planning to upgrade

its network to digital. Pricing for the videoconferencing service is available on their Web site. Their service can also be made available to outside groups at \$100/hr per location. The users attend the existing equipped classrooms for the teleconference sessions.

This network was built using federal grants. There were a total of 6 grants totaling \$6 Million. The operating costs for this network are approximately \$900K per year. One of the major weaknesses of the network is the lack of redundancy. Being analog versus digital also presents some weaknesses.

FLAGSTAFF UNIFIED SCHOOL DISTRICT

The Flagstaff Unified School District (FUSD) administers three high schools, two middle schools, 12 elementary schools and an alternative school (New Start) for high school or elementary school students requiring special attention.

All schools are connected to the Administration Center via T1 over fiber infrastructure provided by Qwest through a DS-3 access. Internet connectivity to all schools is provided through NAU over a single T1 access from the Administration Center. This network supports approximately 4,000 computers with an average of 1,500 concurrent computer sessions. Administrative usage varies by the time of the month and on average accounts for approximately 15-20% of the traffic load. The prime traffic on the network is from the high school computer labs access the Web.

The FUSD connects to the Internet via a T1 to NAU, contracted through the Arizona Public School Computer Consortium (APSCC)¹². This link is “slow” and viewed as inadequate to meet current connectivity demands, let alone future needs. Apparently, connectivity to the NAU network through the APSCC service is limited to a T1.

¹² “Arizona Public Schools Computer Consortium is a cooperative venture of member school districts in Arizona, authorized by a cooperative purchasing agreement among public school districts, charter schools, county school superintendents, and Northern Arizona University.” <http://apsccweb.apscc.nau.edu/services/director/APSCC%20Brochure.pdf>

¹¹ A map of NAUNet is available at <http://www.nau.edu/naunet/nnsitmap.html>.

Consequently, FUSD is looking at other options for higher bandwidth Internet connectivity.

FUSD would like to offer services to both schools, and to students and teachers from their homes through FUSD, but consider this infeasible at this time due to the lack of adequate connectivity. Connectivity is constrained in two areas – from FUSD to the world, and from homes to FUSD. One major example of the services that FUSD would like to offer is some of the services available from the Cox Education Network ASP that was funded by the Arizona School Facilities Board.¹³ However, some of the applications are bandwidth intensive and current broadband connectivity in the Flagstaff area is viewed as inadequate. Although high-speed Internet service is available in much of Flagstaff from Qwest and Flagstaff Cablevision, there are significant areas where this service is not available and many areas where dial-up access connection speeds, even at 28.8 Kbps, is not consistent. One area cited is an approximate 400 home development on West University Avenue with no cable modem or DSL high-speed Internet services available today.

The general understanding is that the outside plant (copper distribution wire) in many areas of Flagstaff and the switching equipment has not been kept current and as a result, this presents a deterrent to providing widespread, quality high-speed Internet service. This school district suggests that the State government should invest in a full-scale analysis of the telecommunications infrastructure in Flagstaff and in many of Arizona's smaller communities.

UNITED STATES GEOLOGICAL SURVEY (USGS)

The Federal Government paid Qwest to install a fiber link to the USGS site from the Qwest Forest Avenue building. There are dual fibers in a common conduit. The fiber is equipped with an OC-3 terminal and USGS has a DS-3 access circuit. Qwest provides a separate T1 to the Jet Propulsion Laboratory in Pasadena, California. There are also T1s to four observatories in the Flagstaff area. The observatories afforded Internet access through the JPL link to NASA.

The USGS head office in Washington, D.C. administers the telecommunications, so the Flagstaff office is not generally directly involved with the purchasing decisions or pricing.

The USGS Internet access is a DS-3 on GEONet (a private USGS network). There are dual Internet portals, one at Menlo Park, California and one at Reston, Virginia, each with dual DS-3s. The Flagstaff USGS field office can burst to DS-3 on its Internet access. The office was formerly on DOINet (Department of Interior Network), but there was some internal disagreement within DOI and the contract was terminated last year. USGS reported that it is very satisfied with the quality of service provided by Qwest. The OC-3 has not failed in the 9 months since it has been installed.

In summary, the telecommunications needs of the Flagstaff USGS field office are well met at the current time. With possibilities of expanding the USGS facility in Flagstaff to accommodate closure of other USGS facilities, these needs will increase and have to be addressed by expanding current DS-3 links with possibly OC-3 ones.

¹³ See <http://www.coxednet.org/vision.html>.

Capabilities

The community of Page is located in the Phoenix LATA Nr. 666. It is served by two exchanges:

- Page Main, owned and operated by Qwest Communications and providing wire line connectivity; and
- Page 07, operated by Southwest Wireless, Inc. serving the cellular user community.

Qwest, after the take-over from US West, attempted to sell its rural exchanges in Arizona, including Page. Citizen Communications showed some interest, however, the sale has not materialized.

In the meantime Qwest is not investing in the upgrade of local or transport infrastructure in the affected exchanges, leading to the infrastructure bottlenecks and long lead times to provision service currently encountered in these exchanges.

Transport

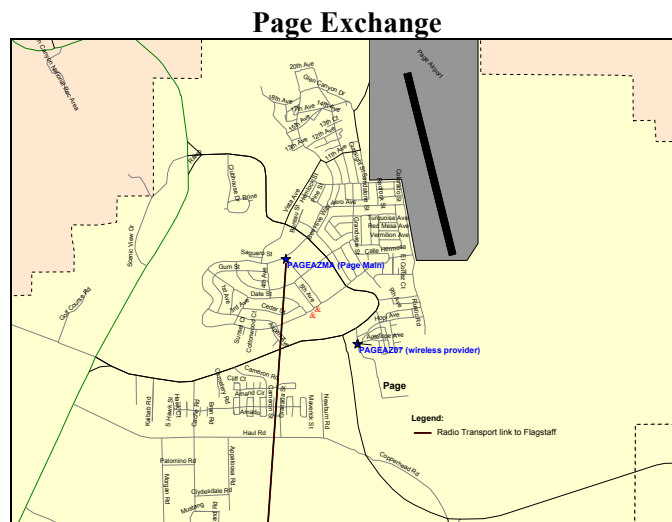
Transport into the Page exchange is over a digital radio link between Page and Flagstaff where it is interconnected to Qwest's fiber transport network to Phoenix. The radio transport link to Flagstaff is

completely exhausted and additional service orders requiring connection to the telecommunications backbone facilities usually need to wait for a cancellation of an existing service to free up bandwidth.

The radio transport facilities were scheduled to be replaced by a fiber optics cable run between Page and Flagstaff to expand the transport facilities into the community. This plan is reportedly currently on hold.

There is a minimum requirement for at least another DS-3, and preferably a fiber installation, before any broadband access offering could be facilitated. In addition, the Northwest edge of the Navajo reservation is within RF line-of-sight of facilities in Page, so that connectivity could be established with existing Navajo Tribal Utility Authority fiber resources. This may be achieved either through fiber or microwave extensions from Page. This effort should be addressed as part of any upgrade in trunks to Page.

The following diagram shows existing transport capabilities.



This lack of transport facilities adversely affects not only the economic development of the region but also the timely introduction of enhanced services

such as cable modem service on Cable ONE's local cable distribution network or any DSL provider offering should they choose to offer those services.

Local Internet access service providers expressed frustrations with the inability to grow their networks and to introduce high speed access services which require additional transport capacity to the Internet backbone.

In addition, Qwest's facilities are single-routed; i.e., there is no diverse route to provide redundancy. No firm plans for expansion of capacity to Page have been committed.

Local Access

The local distribution plant operated by Qwest is primarily copper based. Qwest does not have any local fiber cable runs in Page.

Several local entrepreneurs offer wireless access services in the unlicensed 2.4 GHz range to major users in the community, but is largely incapable of widespread residential expansion.

Services

High speed data services up to T-1 level are offered in Page. ATM service is not available. Due to transport capacity problems, orders for new services reportedly have long lead times.

Qwest is not capable of offering ADSL service in Page until additional high-speed trunks are made available.

Cable ONE has not upgraded its network to be capable of carrying cable modem services and is not planning to introduce cable modem services in Page in the near future for the same reason. Several Internet service providers offer wireless access at tiered rates.

Internet Access Service Pricing

Dial-up services are offered by a number of ISPs at various prices. Neither DSL nor cable modem service is available.

Some wireless is offered, rated by speed. Typical rates are:

- \$45/month for 128 Kbps;
- \$65/month for 256 Kbps; and
- \$85/month for 512 Kbps.

A setup fee averaging \$150 also applies.

Needs

Page would like to see the development of technology-based businesses to reduce the reliance on the tourism industry. These businesses require advanced telecommunications capabilities, which are presently not available. Anecdotal evidence suggest that businesses considering the area have investigated the existing telecommunications services, and chose to relocate elsewhere.

Some issues with basic telephone services were reported within Page. Among these were recurring problems completing local telephone calls and securing a dial tone. It is reported that satisfactory resolution of the problems have not been delivered by the incumbent provider. In addition, new telephone service installations reportedly are prolonged, sometimes taking more than several months.

Residences are served by a number of dial-up Internet service providers. No DSL or cable modem services are available, and as such an unmet need exists for the approximately 7,000 residents of the community. Limited broadband wireless services (2.4 GHz) are reportedly available though firms such as TechData, Canyon Country, and OmniNet.

Anecdotal evidence also suggests that businesses have experienced difficulties, primarily in terms of long delays, in securing T1 connectivity. Since neither DSL nor cable modem service exists, there are substantial unmet needs. Page has its own wireless network serving municipal facilities (spanning the City Hall, Fire Department, Police Department, Public Works Department, Water/Sewer Department, Youth Center, Library, and Airport. The network is reportedly adequate for meeting the City's needs, though broadband internet access is a problem.

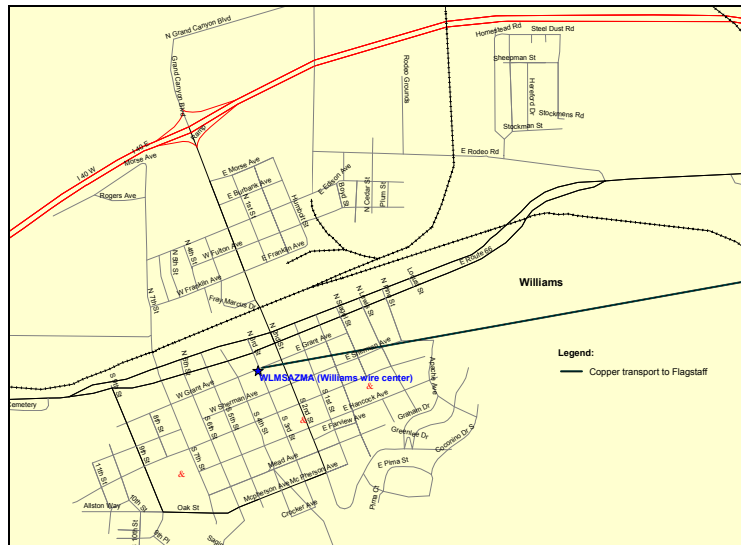
Some significant challenges are reported in terms of communicating needs to the incumbent telephone company. For example, the incumbent provider reportedly would not return calls from City economic development officers investigating whether the capability to support a large call center within Page. Furthermore, the City has reportedly addressed questions related to the capacity of the existing link that have gone unanswered.

WILLIAMS

Capabilities

The community of Williams is located in the Phoenix LATA Nr. 666. It is served by one wire center owned by Qwest Communications. The following shows Williams and its wire center.

Williams



Qwest, after the take-over from US West, attempted to sell its rural exchanges in Arizona, including Williams. Like Page, Citizen Communications showed some interest, however, the sale has not materialized.

In the meantime, Qwest did not invest in any upgrades of local nor transport infrastructure in the Williams exchanges, leading to the infrastructure bottlenecks and long lead times currently encountered in these exchanges.

Transport

Transport into Williams is over copper facilities to the Flagstaff Main exchange where it is interconnected to Qwest's fiber transport network leading to Phoenix. The digital capacity on the copper link to Flagstaff is completely exhausted and additional service orders requiring connection to the telecommunications backbone facilities usually need to wait for a cancellation of an existing service.

Qwest's facilities are not backed up by any arrangement for redundancy with other transport providers.

Relief from Qwest though future investments in fiber or microwave is not expected in the near future because of their financial situation.

Local Access

The local distribution plant operated by Qwest is primarily copper based. Qwest does not have any local fiber cable runs in Williams. Qwest does, on the other hand, operate long-distance fiber (at OC-48 rate) that cannot currently be provisioned to serve as a local broadband access trunk. This may change over time, but it may be years before any upgrade to the Williams CO makes fiber resources available for local access.

There are no local wireless Internet access providers located in Williams, although, Niles Radio has two connections from its Flagstaff base extending to users in Williams. These are principally used for telephony trunking rather than internet access.

Services

High speed data services up to T-1 level are offered in Williams, however, new connections experience long lead times due to transport capacity problems. Qwest is not offering ADSL service in Williams.

The local cable company, Eagle Cablevision, does not have any plans to introduce cable modem services in Williams in the near future - primarily because of the lack of high-speed trunks. There currently are no local wireless Internet access providers in Williams.

Needs

Basic telephone service in Williams was described as being of a high quality and reliability. No difficulties were uncovered relating to service, or service changes or additions. However, significant comments were made regarding poor cellular coverage in the Williams area.

Residential Internet users have no options for high-speed Internet service in Williams. Neither DSL nor cable modem is available, and no broadband wireless providers were identified. As such, a significant deficiency exists here, though one which reflects the realities of the market size (population of about 3,000).

The same situation exists for businesses, except those wishing to purchase T1 or fractional T1 connectivity through Qwest. Discussions suggest, however, that few T1 lines serve the community, reflecting the size and nature of businesses. It was reported that an order for a T-1 circuit placed by neighboring Parks School District. It apparently took 18 months for this order to be filled due to a lack of transport capacity from Williams to Flagstaff. Funding for this facility was in danger of being lost, and only pressure by the Greater

Flagstaff Economic Council led to a completion before loss of funding.

A major concern in the community rests with cellular communications. Analog coverage in the community was described as being extremely limited. Some reports suggest that no digital coverage exists (though recent investments by Sprint may have changed this). The current levels of coverage are deemed not to have a positive impact on investment decisions by firms considering relocation to Williams. Furthermore, discussions identify the present cellular coverage situation is a more important issue than broadband service availability for residents and businesses.

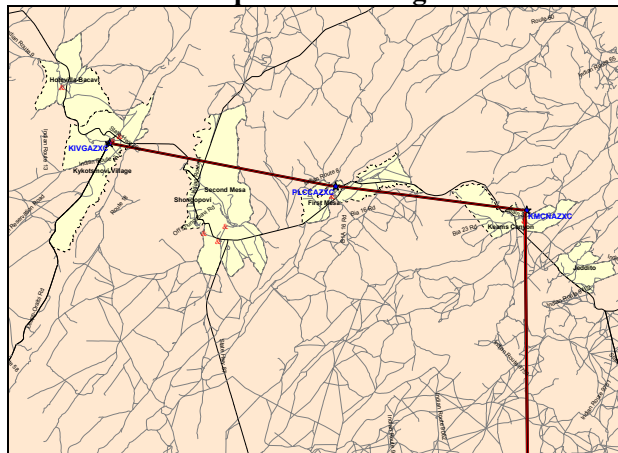
HOPI TRIBE

Capabilities

The Hopi Reservation is located in northeastern Arizona. It is covered by an extension of the Phoenix LATA Nr. 666. The three exchanges of Kykotsmovi Village, Keams Canyon, and Polacca serve the Hopi Reservation. These exchanges are owned and operated by Century Tel of the Southwest headquartered in Keams Canyon, which in turn is owned by Century Telephone Enterprises with head office in Monroe, LA.

The exchanges contain a total of three wire centers (central offices) as shown in the following diagram.

Hopi Reservation Telephone Exchanges and Wire Centers



Transport

Transport into the area is provided by a radio system between Winslow and the Keams Canyon wire center. Transport capacity is sufficient for the level of services currently provided, however, it would need to be upgraded to carry additional traffic - specifically broadband.

There are no plans by Qwest or any other provider to upgrade the transport link into the area or install a new one. One obstacle to such an upgrade would be the lack of transport capacity on Qwest's section of the network between Winslow and Flagstaff, which will not be expanded in the near future.

While AT&T Longlines operates a fiber optic cable along I-40 which could be used as transport backbone to reach Qwest's fiber facilities in Flagstaff, this cable is only accessible within Arizona in Holbrook and Flagstaff. The AT&T Holbrook center is completely filled and there are no plans to upgrade it.

The Economic Development department of the Tribe is currently investigating other options to augment its connectivity to the telecommunications backbone networks and is considering a radio link to Mt. Elden in Flagstaff. This is a two-hop link and would require the lease of tower space in the Navajo Reservation. The Diagram below shows existing tower locations within the Hopi Reservation.

Local Access

The local distribution plant operated by Century Tel of The Southwest, Inc. is copper based.

There does not appear to be a shortage of facilities within the ILEC's operating territory in the Hopi Reservation, considering the services currently provided.

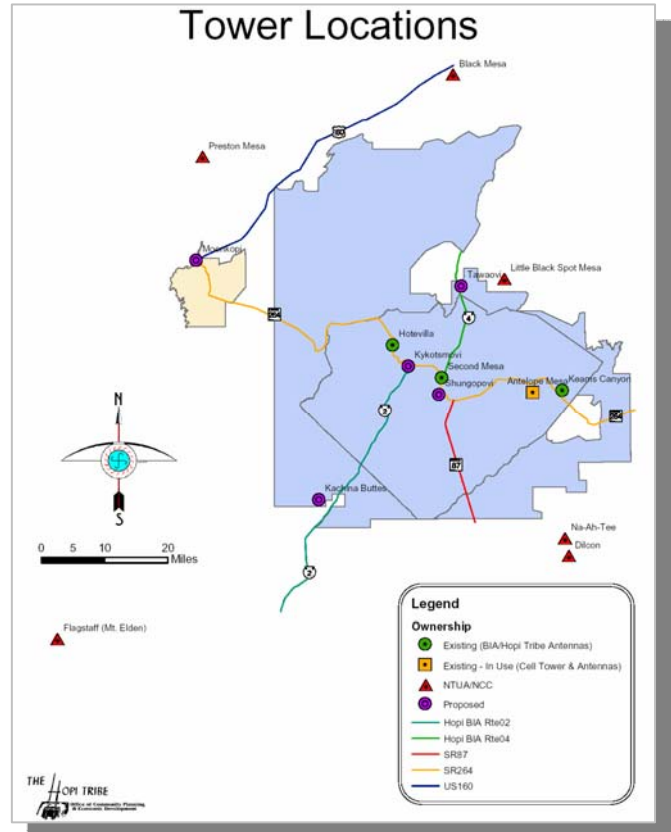
Services

High speed data services up to T-1 level and frame relay services are offered in the exchanges operated by Century Tel of The Southwest, Inc. Internet access is available using dial-up facilities, with the

closest ISP located in Tuba City. Dial-up connections therefore incur long distance charges.

The company is not offering high speed Internet access, and does not have plans to upgrade its transport network, nor to introduce enhanced services such as high speed Internet access with its exchanges on the Hopi Reservation.

Tower Locations on Hopi Nation



Transport between the exchanges operated by the ILEC is carried on aerial copper cable.

Internet Access Service Pricing

Internet access is via dial-up to Tuba City and/or Flagstaff which incurs long distance charges. Broadband service is currently not offered.

NAVAJO NATION

Capabilities

The Navajo Reservation, excluding those areas located in New Mexico and Utah, is located in the Navajo Reservation Arizona LATA Nr. 980. The table below identifies the exchanges serving the Arizona area of the Navajo Reservation and located within LATA 980:

Navajo Reservation Exchanges/Wire Center List

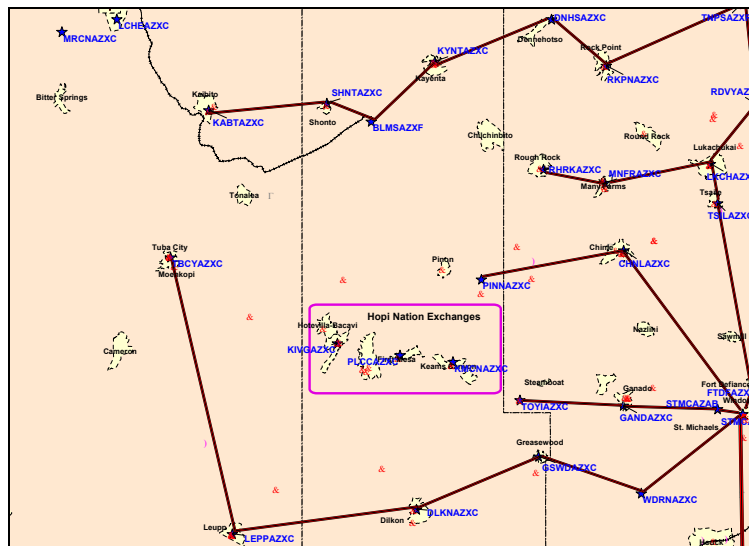
WINDOW ROCK	MANY FARMS
BLACK MESA	PINON-COTTONWOOD
CHINLE	RED VALLEY
DILCON	ROUGH ROCK
DENNEHOTSO	ROCK POINT
FORT DEFIANCE	SHONTO
GANADO	TUBA CITY

GREASEWOOD	TEEC-NOS-POS
KAIBETO	TOYEI
KAYENTA	TSAILE
LE CHEE	WIDE RUINS
LUKACHUKAI	

These exchanges are owned and operated by Navajo Communications Company headquartered in St. Michaels, which in turn is owned by Citizen Communications, with head office in Salt Lake City, UT. The exchanges contain a total of 25 wire centers (central offices) as shown above.

As explained earlier in the report, Citizen Communications was unwilling to provide any infrastructure related data for discussion. Information was obtained from alternate sources and has been second sourced to the largest extent possible. The routing of transport facilities among CO's listed above is based on information obtained in interviews and may not be completely accurate.

Navajo Reservation Telephone Exchanges and Wire Centers



The Navajo Tribal Utility Authority (NTUA) has indicated a desire to augment its telecom network to be able to lease capacity throughout the reservation. The proposed network upgrade is to link to Qwest's telecommunications backbone at Mount Elden in Flagstaff, as illustrated in the table above. A more preferable connections would be through Page

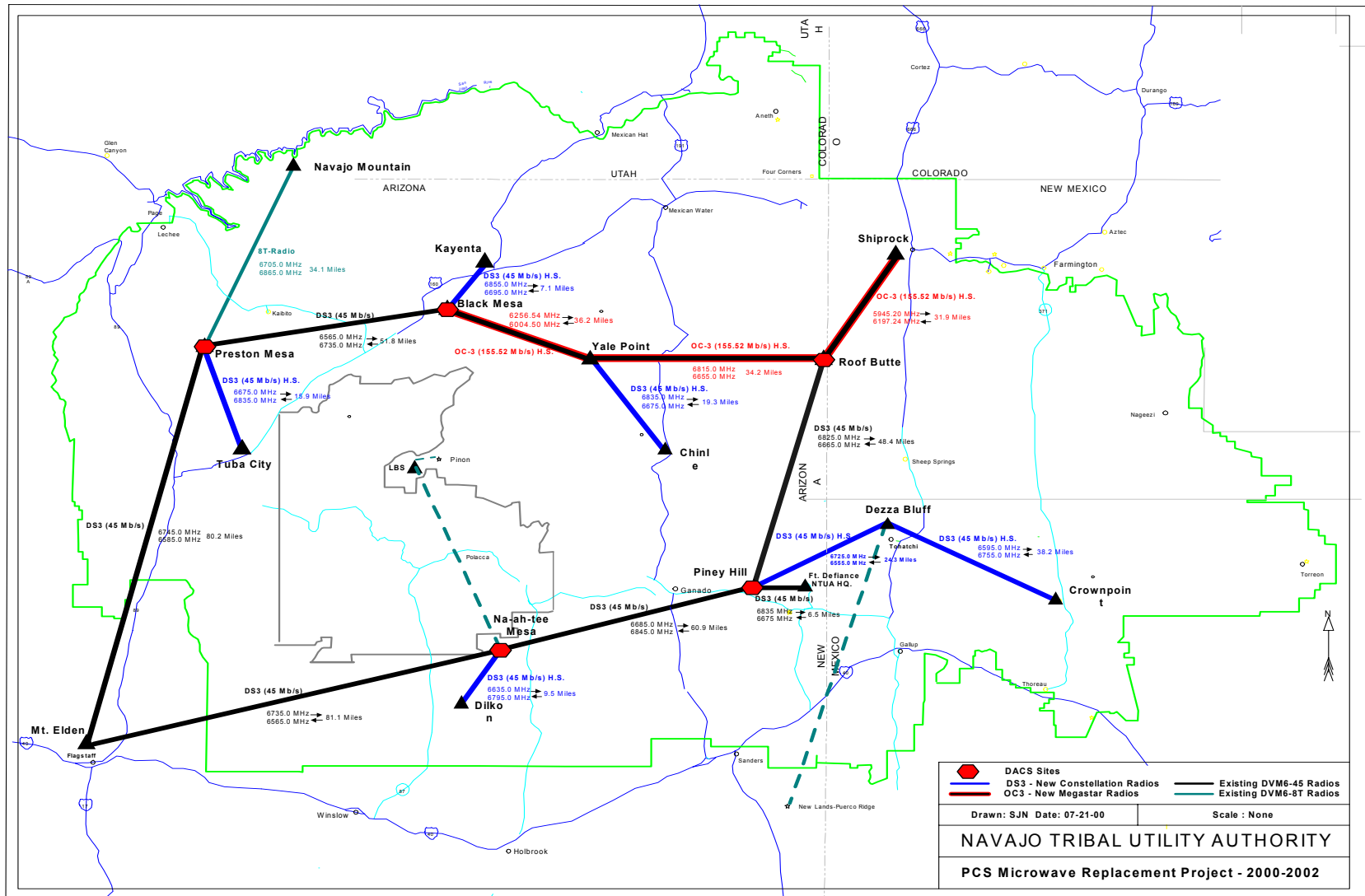
and/or Holbrook if trunks existed in those communities.

The expansion plans by NTUA are proceeding slowly in view of a complex and time consuming right-of-way process administered by the Tribal Council, which can take up to four years to complete.

The Tribal Council in November 2002 set up its own regulatory body called the Navajo Telecom Regulatory Commission (NTRC), overseeing telecommunications in those areas which are within its jurisdiction. This regulatory agency is expected to address the delays inherent in the current right-of-way requirements, and be actively involved in establishing rules and regulations regarding connectivity and services into and out of the Navajo Nation.

The NTUA has established a broadband backbone that traverses the Navajo Nation as shown in the following diagram. This backbone is principally microwave, with fiber segments and access points in various places.

NTUA Proposed Radio Network Upgrade



Transport

Transport into the Nation is provided by a radio system between Gallup, NM and Window Rock connecting to Navajo Communications Company's wire center in Window Rock. Transport between the exchanges operated by the ILEC is carried either on aerial copper cable or microwave radio.

The transport capacity currently available to the telecommunications backbone is sufficient to accommodate existing service requirements, however, it would need to be upgraded to carry additional capacities required by enhanced services such as large scale roll-out of high speed Internet access into rural areas. Ultimately, transport out of the Navajo Communications Company territory needs to be carried by Qwest's intra-Arizona network along I-40 to Flagstaff. This route is completely exhausted and relief has not been identified in discussions with Qwest.

Another alternative would be to use the fiber optic cable along I-40 operated by AT&T Long Lines to reach Qwest's fiber facilities in Flagstaff. This cable

could be accessed in Gallup, NM where AT&T also operates a central office.

Local Access

The local distribution plant operated by Navajo Communications is copper based. No dedicated fiber optics runs were identified within the exchanges, and information is not made available by Citizens.

There does not appear to be a shortage of facilities within Navajo's operating territory in the Arizona region of the Navajo Reservation, considering the services currently provided.

Services

High speed data services up to T-1 level and frame relay services are offered in the exchanges operated by Navajo Communications.

Navajo Communications is offering ADSL service from its wire centers in the following communities within the limitations of 18,000 loop feet envelope:

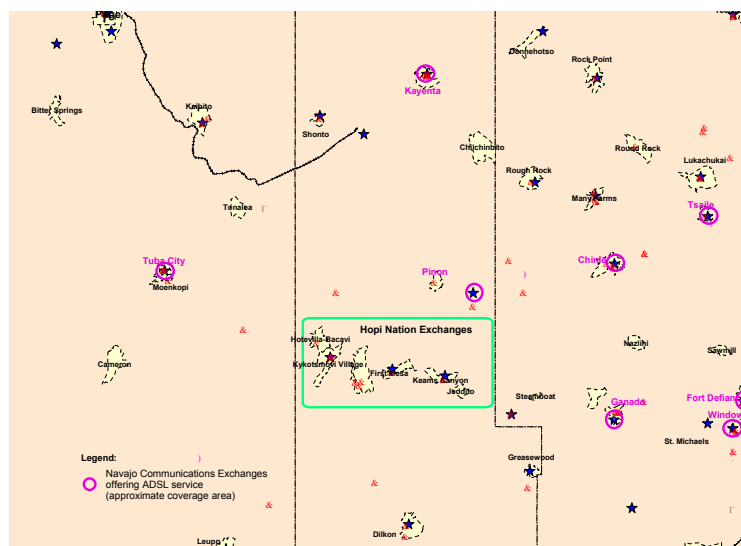
Window Rock
Fort Defiance
Navajo
Tse Bonito (NM)

Ganado
Shiprock (NM)
Chinle
Piñon

Kayenta
Tsaile
Tuba City

The diagram below shows those exchanges operated by Navajo Communications that offer ADSL services, and the approximate coverage area within each exchange.

High Speed Access Availability



Navajo Cable provides services over a uni-directional network and did not indicate any plans to upgrade its network to enable the sale of cable modem Internet access.

Cybertrails provides Internet access over NTUA's network, however, they are currently not offering wireless access services. IndigeTEC, a technology company, is in the process of erecting communications towers throughout the Reservation, which may eventually allow for lease of tower space

by interested parties, such as wireless ISPs. The first four towers are scheduled to be erected in the area of Chinle, Leupp, Tuba City, and Kayenta.

Internet Access Service Pricing

Navajo Communications' ADSL service is currently offered at \$49.95/month. Cable modem service is currently not offered. Dial-up costs vary by provider, keeping in mind that some ISP services - depending on their exchange presence - may be a long distance call.

SUMMARY

After delving deeply into the picture of these Northern Arizona communities, it is clear that there exists significant shortfall in basic transport. Service providers will not generally resist an opportunity to enter new market areas (communities) if 1) middle-mile resources exist, and 2) demand exists. The middle-mile, however, is the expensive part of the equation that either makes or breaks business plans for broadband providers. What is essential to take away from this chapter are the following requirements:

If the State can create a tiered funding mechanism that establishes "ownership" over a diverse broadband back bone as well as provide for continuing support of it, there are incredible benefits to its citizens....

It must somehow be funded without dependency on service provider direct investment (or it may never happen).

Additional broadband capable middle-mile infrastructure could be installed throughout rural Arizona, paving an easy path for broadband service providers to offer services equivalent to metropolitan areas. Any vehicle created to fund middle-mile infrastructure would offer the following benefits:

Cooperative, *low cost* use by State and Local organizations - these may include State and Local government, education, health and human services,

homeland security, judicial, legislative functions, etc. for a very diverse state-wide network.

Reduced cost of broadband and related services to rural citizens since providers did not build infrastructure at *their* expense.

It can also provide a source of bond and/or loan funds for public or private entities to use to entice broadband expansion

Establish a level foundation for economic development to *all* communities in Arizona.

Lays the framework for competitive service aggregation points where public and private entities can obtain the best cost for the services they need.

Creates for the first time, the means to define and implement Service Level Agreements for telecommunications-critical businesses so that they do not incur losses when telecom services have interruptions.

These are but a few of the benefits that might be derived from having ownership and control of resources at a state level. Both infrastructure and funding resources. The Holy Grail of the telecommunications industry is making Fiber to the Home (FTTH) a reality. The initial high-speed path into rural communities has to exist before anything else. Saving money along the way should be viewed as a good thing.

4

REGULATION AND POLICY

What are the rules . . . and what should they be ?

The telecommunications service industry like other utility industries were spawned long ago. But only the most recent thirty years is of principal interest, and especially since the 1984 breakup of AT&T as a means of [presumably] eliminating the Bell Company monopoly maintained for many years.

The monopolistic atmosphere still exists today, in that the Baby Bells created by the breakup still maintain the lion's share of the telecommunications service market with around 85% of the nation's population being "Baby Bell" subscribers. The Telecommunications Act of 1996 - the most recent all-encompassing legislation governing the industry - was created to serve as a legal foundation for fostering competition in the telecom marketplace, and levying regulatory oversight responsibility to the Federal Communications Commission (FCC). The Act also made provisions for states to implement a regulatory organization to scrutinize things like service rates and business practices on a more local basis. In Arizona, the chartered regulatory agency for telecommunications is the Arizona Corporation Commission (ACC).

The Federal Telecommunications Act of 1996 defines telecommunications as follows: The term "telecommunications" means "the transmission, between or among points specified by the user, of information of the user's choosing, without change in the form or content of the information as sent and received" (§ 153(48)). "Telecommunications service" means "the transmission of any electromagnetic communications that passes through the public switched network. The term

includes, but is not limited to, transmission of voice, image, data, and any other information, by means of but not limited to wire, electric conductor cable, optic fiber, microwave, radio wave, or any other combinations of such media." This Telecommunications Plan will not, however, restrict itself simply to transmission issues.

This Plan will examine related issues including the telecommunications industry, the providers, the services they provide, and the applications of these services towards public and private interests. Additionally, this Plan addresses issues related to providers of services (and the services themselves) that are not presently classified as telecommunications by the Act, the FCC or the Arizona Corporation Commission, such as Internet Service Providers, or which fall under separate categories, such as cable television service providers.

While it is obviously difficult to predict the future for an industry most notable for accelerating change, this revision of the Northern Arizona Telecommunications Plan is based on the view that certain trends are clear and corresponding responses and leadership necessary. No matter the direction of particular, individual technological developments, the overall direction of telecommunications technology is, in one sense, predictable -- increased use of the Internet as an information resource of choice, coupled also with services that accommodate mobility. There will be more communications modes, they will be faster, smarter, more pervasive and ubiquitous, and the devices used will be smaller, more mobile and more multipurpose

than before. Phone calls will have the video option, and both television and telephony will integrate with Internet elements, and cable TV is expected to expand its telephony offerings. Many providers offer limited capabilities like these today, and they will improve over time. The vision of this Plan is really not about technology, but about choosing and implementing desired changes for the betterment of Arizonans. The planning questions are not really about technology, but what we must do to make these new means of communication available and affordable on an equitable basis, so that everyone gets lifted up by them, not just the “haves.”

Universal service in 2010 will mean that everyone who wants to be connected should have available and affordable high-speed Internet connectivity. To simultaneously ensure the benefits of free competition, customers should be able to choose their telephony, television, and Internet service provider independently from their choice of the provider of the conduit. Local competition should remain technologically neutral.

Enabling Arizonans to become information providers as well as consumers, by providing access to production facilities, training and technical support, encourages the creation of local information, resulting in what is frequently called a local information infrastructure. This access must be local, available and affordable; it must enable people to retrieve, create and exchange information, and must ensure equity and prevent inequity. Education and training for the public must be available at community-wide levels.

By creating a local information infrastructure, the ease of accessing and exchanging information using the Internet will become part of the fabric of the Arizona lifestyle. Logging onto your town’s or county’s home page should bring you access to the information you need to conduct your day. You can check out the National Oceanic and Atmospheric Administration (NOAA) weather maps and local forecast, send a message to your daughter’s teacher that you’ll be picking her up early to take her to the dentist, purchase your town’s winter parking permit, order some supplies from the hardware store, and take that cooking lesson or find that recipe for dinner. You can view your state legislator’s speech on school funding and send her your comments.

You can check the schedule at the library, the movies and the recreation center, and sign up for that folk dancing class. If it’s really icy you can log into your office local area network (LAN) and do your work from home, conducting impromptu video phone calls with one or more colleagues in Arizona or anywhere else. As for town issues, everyone should be able to frequent the town’s online Forums, exchange information and form opinions on every facet of town life, from the development of the new downtown to the state of the sewer plugs on your block. Through greater interaction between constituents we strengthen our real local community in every town, county and for the state as a whole.

By taking a proactive approach and building from the bottom up, we can do for our community in the next ten years something akin to but greater than what the telephone accomplished over the last 100. As new technologies enhance the services available in Arizona, the goals and vision established in the plan must also direct our actions. Modern, high quality communications capabilities must be made universally available, and they must be affordable.

The approximately 5% of Arizona’s population still unconnected to the public switched network must be given every opportunity to get connected and receive basic service. New applications and secure transactional capabilities must be developed and deployed for improving public safety, commerce, tourism, education, entertainment, convenience and personal communications. As we would expect in any community, privacy and consumer rights must be protected in all new applications.

ARIZONA CORPORATION COMMISSION (ACC)

The ACC is the principal regulatory agency with responsibility for overseeing all telecommunications industry (and other utilities’) activities in Arizona. They administer both plans and policy - in coordination with other governmental agencies at the State and Federal level - regarding provider territorial boundaries, rights-of-way, tariffs, and consumer issues. Details of the regulatory and administrative functions of ACC, along with a wonderful expose on telecom regulation in Arizona

is available at the following ACC web site: <http://www.cc.state.az.us/utility/telecom/index.htm>. The rules applied to the telecommunications companies in Arizona are listed on ACC's web site, and are also available at the following Hyperlink: [Title 14, Section 5](#).

One of the least known and understood programs administered by the ACC is Arizona's Universal Service Fund (AUSF). An equivalent program administered as the Federal USF, is a program defined and regulated at the Federal level by the FCC. The USF serves as a principal means by which funding can be accumulated and distributed back to providers for infrastructure expansion. For rural residents, these funding mechanisms ensure that "life-line" telephony infrastructure is made available at an affordable cost, when providers might otherwise resist laying that infrastructure in remote areas for business case reasons.

A description of the AUSF is provided here so the reader can envision the concept of how funding might also be made available for similar infrastructure requirements in support of broadband expansion.

UNIVERSAL SERVICE FUND

What is the Arizona Universal Service Fund (AUSF)?

The Arizona Universal Service Fund (AUSF) is available to qualifying telecommunications carriers to help fund the costs of providing service to customers. Article 12 of the Arizona Administrative Code contains the rules that the ACC uses to administer and implement the AUSF.

How can the AUSF help carriers and customers?

The AUSF can help provide carriers with the funds they need to serve high cost and rural areas. Customers in these areas can benefit if their carrier qualifies to receive AUSF funds. Those customers would likely experience lower rates than they would have had if their carrier could not receive AUSF. Also, there are some areas where the costs to extend lines to customers are so expensive that a carrier cannot serve customers in those areas. Following rule revisions, the AUSF may be able to be used to fund line extension costs. These customers would

benefit by being able to have telecommunications service where before they could not have afforded the line extension costs and would have gone without service.

How would a company receive AUSF?

Companies interested in applying to receive AUSF would make a rate case filing with the ACC. Having companies file rate cases in order to receive AUSF is being reviewed in our rulemaking proceeding.

Are the AUSF rules being reviewed?

Yes, currently the ACC is reviewing the AUSF rules for revisions, additions, or deletions. This proceeding will likely continue throughout 2002. The docket number for this proceeding is: RT-00000H-97-0137.

2003 Rates Approved by Decision No. 65472

Category One providers:

\$0.009119 per access line

\$0.091193 per interconnecting trunk line

(Category One companies provide basic local exchange service, wireless service, paging service and other commercial mobile radio services that interconnect with the public switched network.)

Category Two providers:

0.1565 percent of intrastate toll revenues

(Category Two companies provide intrastate toll service)

The National Exchange Carriers Association ("NECA") administers the fund on behalf of the Arizona Corporation Commission including the annual revenue requirement and assessment rates, collections, and disbursements. If a company is required to begin collecting and remitting AUSF fees, they may contact Donna Casey of NECA at 973-884-8531 to obtain the correct forms.

RIGHTS-OF-WAY

Arizona Law regarding rights-of-way (ROW) are prescribed under Title 40 of Arizona's Statutes.

These are available from the Arizona Legislature web site at:

<http://www.azleg.state.az.us/ars/40/title40.htm>

Specific portions applicable to “rights-of-way” for telecommunications and utilities are prescribed in Chapter 2, Article 4, Section 40-283, viewable from the web site above. A local copy of Section 40-283 is also made available with Compact Disk forms of this Plan using the following hyperlink: “[Section 40-283](#).”

Specific rules that might apply as inhibitors to providers’ willingness to infrastructure expansion include:

- Municipal authorities of incorporated cities have authority to impose license requirements and/or franchise fees in accordance with Title 9, Chapter 5, Articles 1.1 and 4. If these are considered unreasonably high, providers may be unwilling to invest because of unacceptably long returns on investment (ROI) that result.
- In instances where public ROW are involved, public resistance to infrastructure projects may impose constraints that prevent providers from pursuing expansion projects.
- If projects involve boundary conflicts, transiting private rights-of-way, or obtaining rights-of-way from one or more sovereign nations (e.g., Navajo, Hopi, or other American Indian reserve), matters of obtaining all necessary rights may be considered “not worth the effort” if time and/or cost exceed expectations.

While general rules regarding ROW in Arizona are fairly unrestrictive, each instance of infrastructure planning should be considered unique, and may present many difficulties. The process of investigation and relationship building is crucial to minimizing the time it takes to obtain all the necessary permissions at minimal or, in some cases, no cost to providers.

Rethinking public rights-of-way governance. This is an interesting issue in that it is one of the few under the broadband umbrella where all sectors of the industry (Bell Operating Companies, CLECs, cable providers, cable companies, overbuilders, and wireless providers) actually share the same point-of-view. That view is that constraints imposed by

certain municipalities and federal government landowners on accessing public rights-of-way and tower sites might be inhibiting or at least delaying broadband network construction. While the industry admits that the problems seem to lie with only a small number of jurisdictions, due to the nature of networks, a few bad actors can have a disproportionately adverse effect on the roll-out of uninterrupted statewide or regional advanced services networks, which ultimately can inhibit broadband deployment on a broad scale.

To ensure that rights-of-way regulation is appropriate and not an impediment to broadband deployment, NTIA is working closely with the National Association of Regulatory Utility Commissioners (NARUC), and particularly its Rights-of-Way Study Committee, to help identify best practices and recommendations for States to streamline the current process. NTIA is also meeting with representatives of the cities and their association, the National Association of Telecommunications Officers (NATOA), to identify means for improving and simplifying their current processes, while ensuring sufficient flexibility for municipalities to best serve their citizens. NTIA is also working on an initiative to streamline and improve the rights-of-way oversight practices of federal government agencies. Government – both Federal and State -must take the lead on this issue.

TRENDS THAT AFFECT TELECOM EXPANSION

FCC is moving on all fronts with proposals for broadband regulatory reform. The agency has been under fire since the release of the 1996 Telecom Act, having been inundated by litigation over “competitive access” portions of the Act. As a related issue, the RBOCs and other telephony-based broadband providers have been challenging the FCC over data network tariffs and deregulation that puts them in parity with cable network offerings as a means of “leveling the landscape.”

Most surveys indicate that cable companies have the lion's share of the broadband market these days (recent data indicates cable modem subscriptions leads DSL by a factor of 3). The answer to this dominance question is important, because if the

telephone companies are found to be non-dominant, their broadband services will be exempt from a number of strict regulations and reporting requirements, including the filing of tariffs. In essence, this FCC is looking at the appropriateness of deregulating the "retail" provision of Internet access, and also at delineating internet access as an "information service" versus telecommunications or entertainment service. Cable modem service providers have reaped significant advantages over DSL offerings in the past by being exempt from tariffs or franchise fees on data offerings.

Unbundled Network Element (UNEs). The FCC has placed extensive focus on defining competitive access network boundaries at the "UNE" level, and upon the right mix of regulation and deregulation of the broadband wholesale market. To what extent should an ILEC's competitors have the right to demand and receive "pieces" of the ILEC's network at special discounted rates under TELRIC pricing? As might be anticipated, the ILECs are making their case for shortening the current list of network elements subject to unbundling, while the CLECs are arguing for expanding the list.

The Supreme Court Decision in TELRIC. A very large judicial shadow falls over the entire landscape of broadband. Last fall, the Supreme Court heard oral arguments concerning the legality of FCC-mandated TELRIC pricing policies - which require that ILECs offer access to their networks at 40-50% of costs. CLECs say this pricing mandate is essential to the survival of local competition. The Supreme Court placed the responsibility back in the hands of the FCC, which ruled in August 2003 that levied much of the responsibility on State regulatory bodies to manage on a more local basis.

The details of the findings are contained in a 576-page FCC Ruling 03-36 dated 21 August 2003.

Public Safety Interoperability - Local, state and federal public safety organizations have historically found the right communications solutions for their particularized needs. This is entirely understandable and appropriate. However, in times of emergency, there is an obvious need to be able to link all the pieces of the public safety community together through a common communications capability. Simply stated, "interoperability" is needed to ensure

that every key organization can communicate with every other key organization - no matter what equipment, network architecture, or system they individually selected. This is obviously a challenging area, but one the National Telecommunications Industry Association (NTIA) has placed among its highest priorities.

Critical Information Infrastructure. Keeping the nation's key transportation, energy and public service organizations keep running in times of crisis is a key goal. While public safety is an obvious area of concern, so too is keeping our key public "service" companies and networks operating. NTIA will be working with the [critical infrastructure](#) industry representatives to see how, where and in what way safeguards can be strengthened and improved for our transportation systems, energy sources, financial and other networks.

Modernizing Spectrum Policies - This means taking a fresh look at legacy rules and restrictions to assess their ability to accommodate emerging technologies or spectrum needs. As a starting point, NTIA has already supported the [elimination of spectrum caps](#) and the [liberalization of spectrum leases](#). The FCC's Biennial Review is expected to raise the priority on wireless spectrum availability and services, looking for additional opportunities to advocate the removal or modification of vestigial and unnecessary obligations that could improve spectrum use.

The FCC has come under intense pressure to remap segments of the RF spectrum to make additional commercial broadcast frequency space available. This would significantly improve the possibilities of wireless expansion. However, there is resistance from government agencies - particularly DoD - because of the potential impact to systems they use. Counter to those arguments, there is also a growing ethos in the engineering community¹⁴ to move toward an "Open Spectrum," which essentially proposes migrating away from dedicated frequency space toward a totally open use of available RF spectrum through the implementation of spread spectrum, power management, and a vision of

¹⁴ Information regarding the "Open Spectrum Movement" is available at: http://www.nomaditel.com/open_spectrum.htm

evolving current radio technologies to fully programmable, adaptable “software radios.” Some preliminary demonstration of the concept are demonstrable today, but implementation on a broad scale is many years from reality.

SUMMARY

The most important regulatory issue that continues to affect broadband investment and expansion is the ongoing legal battle over competitive access policies prescribed in the 1996 Telecommunications Act. The cost in terms of both time and dollars to Telecom start-ups has been devastating. More than 70% of the wannabe competitors have failed financially because of legal maneuvering of the Baby Bells, and the list keeps growing.

Fallout from FCC decisions can and will have a major effect on provider willingness to invest and/or offer specific services. A complete dossier of issues being addressed by the FCC are available at their web site: <http://www.fcc.gov/>.



5

STAKEHOLDER NEEDS

Who needs what?

Broadband – high-speed, always-on Internet connectivity – represents the next phase in the evolution of the Internet. Most experts predict broadband will enable applications and services that transform our economy, education, health-care, R&D, homeland security, military effectiveness, entertainment, government and the quality of life for citizens around the world. The deployment and usage of broadband will significantly impact the global competitiveness of nations and businesses in the future.

Not surprisingly, many nations, states, cities and communities are trying to accelerate the deployment and usage of broadband networks. To date, these efforts have predominantly focused on the supply side – promoting infrastructure build-out and determining appropriate competition and regulatory policies.

Since the primary role of government economic policy is to set an environment that encourages capital formation, rewards risk and encourages competition, investment and innovation, supply side inquiries remain vitally important. Supply side decisions are also critical because we'll need significant upgrades of existing network infrastructure to supply the last mile bandwidth required for advanced applications - today's broadband will be tomorrow's traffic jam, and the need for speed will persist as new applications and services gobble up existing bandwidth.

It is also important and appropriate to consider the demand side – factors impacting business and consumer uptake. President Bush has instructed his

Administration to be aggressive about the deployment of broadband, and while the FCC, NTIA and others have aggressively focused on supply side issues, the President's Council of Advisers on Science & Technology (PCAST) and the Technology Administration (TA) have turned our attention to the demand side. TA's efforts have included multiple expert roundtables, independent research and hundreds of stakeholder discussions to assess the factors impacting the pace of broadband uptake and usage by consumers.

We have found that demand for broadband is robust, although as with most new technologies, broadband supply currently exceeds demand (in all but the most rural markets). There are several factors that impact of demand. For *consumers* these include concerns over 1) cost; 2) disappointment with the quality and types of content available (especially lack of movies, music and local information); 3) inadequate customer support and lack of plug-and-play consumer premises equipment; 4) and lack of confidence in the Internet due to security and privacy concerns. For *businesses*, barriers to greater broadband demand stem from 1) price concerns (exacerbated by economic uncertainty); 2) lack of access to DSL or cable; 3) failure to perceive the returns on investment in broadband; 4) lack of understanding about how to implement broadband business solutions that make sense for company strategy; and 5) concerns over security and other legal uncertainties.

The factor most likely to accelerate broadband demand is the creation and deployment of easily understood, value-added business and consumer

applications at prices that meet the needs of the market. New applications and services that consumers want and businesses need will provide the tipping point for broadband demand and usage. At the same time federal, state and local leaders can take steps to accelerate broadband demand, and we highlight many such steps in the final section of this report.

WHERE DO WE STAND?

The State of Broadband Demand is changing. While prior centuries were dominated by nations with superior industrial or agricultural capabilities, the innovation age rewards new competencies and strengths. Knowledge – ideas and the people who generate them – is the new coin of the realm. Innovative capacity is the key driver of future economic prosperity.

Cross-cutting emerging technologies such as genomics, bioinformatics, quantum computing and nanotechnology promise even faster change and deeper disruption in the future. It is no exaggeration to predict that there will be more change in the next 30 years than we witnessed in all of the 20th century.

While America enters this new age of innovation following 60 years of global technology preeminence, our future innovation leadership is anything but assured. In fact, it's very much at

stake. Our ability to remain a global technology (and thereby economic) leader will depend upon a variety of factors including:

our ability to attract, retain, and educate the best and brightest scientists and technologists; our support for world-class R&D and innovation in the public and private sectors; our success in fostering a business environment that rewards risk and encourages entrepreneurship; and our ability to maintain a world-class information infrastructure.

There may be no element more critical today than ubiquitous and affordable high-speed Internet – broadband. The deployment and usage of broadband networks will significantly impact the global competitiveness of nations and businesses in the 21st Century.

INTERNATIONAL COMPARISONS

The importance of broadband has not been lost on leaders around the world. While the United States has the largest total number of Internet users, broadband users, businesses online, and e-commerce transactions (both B2B and B2C, both by volume and value), other nations are gaining ground fast.

The following chart highlights relative positions at the end of 2001 among the broadband leaders and is based on data provided by eMarketer analyst Ben Macklin in his comprehensive August 2002 report “Broadband & Dial-Up Access.”

COUNTRY	Broadband Households (in thousands)	Broadband as % of Total Households	Internet Households (in thousands)	Internet as % of Total Households
United States	11,200	10.4%	56,379	52.3%
South Korea	7,500	51.7%	8,265	57.0%
Japan	2,570	5.8%	21,497	48.2%
Canada	2,300	19.7%	6,505	55.6%
Germany	2,090	5.4%	14,858	39.1%
Taiwan	1,125	18.2%	2,604	42.0%
France	605	2.5%	7,448	30.4%
Netherlands	550	8.1%	4,196	61.7%
Hong Kong	545	26.0%	1,241	59.1%
Sweden	542	13.4%	2,546	62.1%

Source: eMarketer, “Broadband & Dial-Up Access” August, 2002

This chart does not show the *availability* of broadband to citizens in each country, nor are we aware of such an international comparison. Yet no analysis of broadband demand can proceed without an initial look at supply – availability – of current generation high-speed connections.¹⁵

The National Cable & Telecommunications Association reports that over 75 million U.S. households can now get cable modem broadband access if they want it. (NCTA, Sep. 2, 2002).

In recent statements, the regional Bell operating companies reported relatively wide and growing broadband availability:

- Bell South reported that it had increased its broadband coverage to 72% of the households it serves (July 22, 2002).
- SBC reported broadband availability to 26 million customer locations, roughly 64% of its wireline customer locations (SBC DSL Update, Aug. 2002).
- Verizon said it had “deployed DSL to central offices serving 79% of the company’s access lines” as of the end of 2001 (Verizon Investor Quarterly, Jan. 31, 2002).
- Qwest has stated an intention to increase from 45% broadband availability at 2001 year-end to 70% by the end of 2002 (Dec. 31, 2001).

In 2001 Morgan Stanley Dean Witter estimated that 90% of Americans will be able to sign up for either DSL or cable by the end of 2002, although other data has suggested that only 31% will have a competitive choice between these transmission platforms.

The Federal Communications Commission (FCC) recently concluded that “advanced telecommunications capability is being deployed in a reasonable and timely manner,” with 97% of Americans living in zip codes where cable or DSL service is available (although not necessarily directly available to them). (FCC, “[Third Report on](#)

[the Availability of High Speed and Advanced Telecommunications Capacity](#),” Dec. 17, 2002).

The most current study of broadband availability to U.S. businesses found 56% of small businesses, 85% of medium size businesses, and 87% of large businesses had access to broadband services if they wanted them. (eMarketer “Benefits of Broadband” report citing Cahners In-Stat Group, Apr. 1, 2001).

Broadband availability has been more concentrated in urban areas with greater linear population density, with smaller and rural communities seeing deployment less rapidly. Satellite and fixed wireless broadband solutions continue to emerge.

It is important to note here that the current generation of broadband technologies (cable and DSL) may prove woefully insufficient to carry many of the advanced applications driving future demand. Today’s broadband will be tomorrow’s traffic jam, and the need for speed will persist as new applications and services gobble up existing bandwidth. While long-haul data transport capacity exploded in the 1990s¹⁶, last-mile capacity upgrades have proceeded much more slowly. Estimates for new investments needed to build out a significantly more robust and capable national broadband Internet range from \$100 billion conservatively estimated by the National Research Council to \$200 billion according to Bear Stearns, to more. Regulatory certainty, reasonable returns on investment and long-term competitive markets are all going to be necessary if the private sector is going to make these investments and deploy the next generation networks.

U.S. UPTAKE / DEMAND

Broadband uptake among U.S. households has also been growing very rapidly, fueled by robust demand.

Nationwide, new broadband subscriptions increased by 400% between June 2000 and June 2002 to 24 million users (not households), according to the Pew Internet & American Life Project (Pew, June 25, 2002). Pew reports user growth of 33% in the first 5

¹⁵ It is important to observe that there are few consistent definitions of what constitutes “broadband.” International definitions vary, and companies are marketing “broadband” services at speeds ranging from 40kbps to 100mbps.

¹⁶ Andrew Odlyzko, a researcher at the University of Minnesota, noted that fiber transmission capacity grew over 25,000% between 1998 and 2001 (due to new fiber deployments and new DWDM technologies), while network usage (demand) only grew 400%.

months of 2002, while the FCC reported growth of 33% in the second half of 2001.

Consistent with these findings, NCTA reported 67% cable broadband user growth between August 2001 and August 2002. For Q2'01 to Q2'02, Verizon reported 79% DSL user growth, SBC 67%, Qwest 37% (with 81% DSL revenue growth), Bell South 111%, and Earthlink 74.6%.

Nielsen NetRatings reported strong broadband demand and subscriber growth in some of the biggest U.S. cities between April 2001 and May 2002 – up 71% in New York City, 88% in Los Angeles, 48% in Boston, 153% in Washington, DC and 21% in San Francisco. (Nielsen NetRatings, May 2002).

At this pace, consumers are adopting current broadband technologies at a faster pace than CD players, cell phones, color TVs and VCRs. (R. Pepper, FCC).

As with the deployment of almost all new technologies, higher income households are showing greater demand for broadband than lower income households.¹⁷ This likely reflects greater purchasing power, higher dial-up Internet penetration, higher PC ownership and higher

education levels. Leichtman Research Group reported on online demand by income on September 17, 2002, finding:

(Source: “Broadband Internet Adoption Driven by Higher Income Groups,” Leichtman Research Group, Sept. 17, 2002).

Overall, broadband Internet usage accounted for more than half of all time spent online in January 2002, outpacing dial-up Internet access for the first time, according to Nielsen/NetRatings. (Nielsen NetRatings, Mar. 5, 2002). And projections for future U.S. broadband demand remain bullish, with Solomon-Wolff Associates predicting around half of the Internet users in the U.S. will access via current generation broadband by 2004. (Of course, similar bullish predictions were hallmarks of the Internet bubble of 1999-2000).

As encouraging as the access and subscription statistics are, we have a long road ahead. To realize the true benefits of broadband, nations will want to encourage ubiquitous access and widespread usage of higher-speed networks – to close the demand gap. Right now only 20% to 30% of the U.S. Internet population uses broadband, and only 60% of the overall population has any Internet service at all.

Before turning to policies and actions that impact the pace of broadband demand, it is useful to consider why we should care. What makes broadband so valuable and important? What are some of the most promising future broadband applications and how might they impact us?

WHERE ARE WE GOING?

SOME FUTURE BROADBAND APPLICATIONS AND POSSIBLE IMPACTS:

The following section highlights the myriad ways in which broadband can, or is predicted to, transform the economy, education, health-care, R&D, homeland security, the military, and the quality of life for seniors and those with disabilities, among others. These possibilities make clear that there is

INCOME	Have Broadband	Want Broadband	Not Online
<	4%	12%	70%
\$35 -	11%	20%	51%
\$50 -	14%	24%	40%
\$75 -	17%	30%	29%
Over	28%	37%	15%
Mean	\$69,200	\$62,700	\$41,700

¹⁷ More rapid deployment of new technologies in higher income / more urban areas is neither surprising nor symptomatic of a serious problem or market failure – yet. It is particularly encouraging to observe recent Education Department statistics showing 90% of the lowest income schools with access to broadband (as compared to 84% of the wealthiest). Lowest income schools had the fastest adoption rates as well (21% gain in one year). (Internet Access in U.S. Public Schools and Classrooms: 1994-2001, Sept. 2002).

no shortage of “killer” applications in the pipeline, and their impacts are likely to be very significant.

As these services and applications become available, they will drive broadband and justify the investment for citizens, businesses and governments. At the outset, however, it is worth observing that broadband alone has minimal impact. Businesses simply switching to high-speed access will not suddenly save millions of dollars or begin producing more competitive goods or services. Likewise, consumers should not expect instantly better lives or more fulfilling relationships just because they signed up for broadband. Broadband is an incredible enabling technology. It allows businesses that are willing to embrace Internet business solutions to transform business processes and realize significant returns on investment.

It offers consumers new opportunities to work or learn more productively (at their desks or from home), publish multimedia, switch from viewers of entertainment to participants, and – most importantly – dramatically expand their communication possibilities.¹⁸ But these transformations are not always plug-and-play solutions – they often take work and effort. That said, the following broadband-enabled applications should ensure widespread deployment and justify efforts to stimulate growth.

ECONOMIC BENEFITS OF BROADBAND

PROMOTING JOBS, PRODUCTIVITY AND SUSTAINED GROWTH

Economists are already predicting significant macroeconomic benefits from the proliferation of broadband networks. It is believed that widespread broadband usage can extend the IT revolution and further improve national and regional productivity, helping to promote robust economic growth and increase our standard of living.

¹⁸ Communication remains the single biggest reason for going online. Email is the most popular activity among dial-up, broadband and mobile Internet users. IP telephony, video conferencing, digital photo exchanging, unified messaging, and e-learning all represent broadband-enabled enhancements to a basic need – communication. One can get caught up in technologies and applications but when one gets down to it, communicating with others is the primary driver of Internet use. Even voice is touted as a potential “killer application.”

In the most extensive economic study of broadband to-date, economists at the Brookings Institution estimate widespread, high-speed broadband access will increase our national GDP by \$500 billion annually by 2006. (Crandall and Jackson, “The \$500 Billion Opportunity: The Potential Economic Benefits of Widespread Diffusion of Broadband Internet Access,” July 2001).

In a New Millennium Research Council study, TeleNomic Research predicts that building and using a robust, nationwide network will expand U.S. employment by an estimated 1.2 million new and permanent jobs. (Pociask, “Building a Nationwide Broadband Network: Speeding Job Growth,” Feb. 25, 2002). These jobs include direct labor associated with deploying and maintaining broadband investment, direct labor associated with manufacturing the infrastructure components and consumer premises equipment, and indirect labor associated with creating services and applications that would ride on advanced networks.

A separate Brookings study from May 2002 suggests that “failure to improve broadband performance could reduce U.S. productivity growth by 1% per year or more.” (Ferguson, “The United States Broadband Problem: Analysis and Recommendations,” May 31, 2002).

Experts convened by the Technology Administration at a roundtable discussion of broadband and business productivity identified broadband as the critical element enabling applications that transform business processes, such as supply chain management, customer relations management, telework, collaboration, virtual manufacturing, e-learning, and video conferencing. (TA Roundtable on Broadband and Business Productivity, Mar. 25, 2002).

372 U.S. IT professionals responding to a July 2002 InfoWorld survey reported the top five broadband benefits as:

- Improved productivity (78%)
- Faster desktop access (76%)
- Ability to handle data-intensive applications (57%)
- Ability to handle more users (53%)

- Ability to handle multimedia (51%)

In the "Net Impact Study" conducted by the University of California-Berkley, the Brookings Institution and Momentum Resources Group credited e-business solutions with cumulative cost savings of \$155 billion to U.S. organizations through 2001. Internet business process solutions are expected to produce \$373 billion in cost savings by 2005 and more than \$500 billion by 2010, based heavily on high-speed applications. (Varian, "The Net Impact Study," Jan. 2002).

National Association of Manufacturing President Jerry Jasinowski predicts accelerated broadband deployment "represents a major priority for continued increases in productivity for [US manufacturers]... particularly for smaller, independent manufacturers, who are less able to afford expensive upgrades." (NAM, Apr. 2002).

Because broadband technologies are so new (and continue to evolve), there are no definitive studies of their actual impact on regional economic growth and tech-led economic development. Of course that never prevents economists and technologists from speculating or estimating. Gartner Consulting predicted that faster broadband deployment in Michigan will help create nearly 500,000 new jobs and \$440 billion of additional economic output over the next 20 years in a 2001 research report prepared for the Michigan Broadband Development Authority.

Specific regional economic development benefits anticipated as a result of greater broadband deployment and usage include:

- Job creation and retention. Broadband availability allows local businesses to remain competitive, operate more efficiently, and access more consumers more quickly and thus grow faster. Smaller manufacturers need access to high-speed networks to remain part of the supply chain of larger players.
- Reduced traffic congestion and automotive pollution through increased telecommuting. (Macklin, "The Benefits of Broadband," eMarketer, May 2002).
- More successful industrial growth, recruitment and retention. Information businesses can start and locate anywhere they want, and they tend to

look for areas with educated workforces, advanced infrastructures and high quality of life. Knowledge workers expect and require advanced telecommunications infrastructure.

- Improved K-12 education systems. We have just begun to scratch the surface of technology-based improvements to education and have miles to go. Today's children are often immersed in digital technologies their entire lives except when they're at school, where technology is inadequately used.¹⁹ Integrated into learning by trained teachers, broadband connections can improve education for students..
- More productive research and development. A July 2002 Technology Administration roundtable on "BioCenters of Excellence" heard from several biotech and economic development leaders that high bandwidth connectivity is critical to advanced biotechnology research and database access.
- Increased start-up and entrepreneurial activities. The Internet enables entrepreneurship, facilitates networking critical to funding start-ups and encourages rapid tech-led economic growth, with broadband empowering smaller players to compete against larger and more established companies. (See, e.g., National Commission on Entrepreneurship Testimony before the House Small Business Committee, Apr. 3, 2001).
- Urban core revitalization. In cities around the nation, broadband-enabled cyber districts are transforming large blocks of formerly empty warehousing and manufacturing space into highly sought-after post-industrial hubs. For example, Pittsburgh has turned former steel plants into Digital Greenhouses and research centers incubating new companies and

¹⁹ Education Secretary Rodney Paige recently observed: "[W]e still educate our students based on an agricultural timetable, in an industrial setting, yet tell students they live in a digital age. The problem is not that we have expected too much from technology in education – it is that we have settled for too little. Many schools have simply applied technology on top of traditional teaching practices rather than reinventing themselves around the possibilities technology allows. The result is marginal – if any – improvement." (See Sec. Paige Preface to 2020 Visions: Transforming Education and Learning Through Advanced Technologies, Sept. 17, 2002).

technologies. (See, e.g. “Knowledge Value Cities,” Milken Institute).

- Improved government efficiencies and service delivery through e-government.

Certainly the deployment of broadband will be critical to establishing markets for the next generation of high tech equipment. Increasing the speed and capacity of data networks will enable innovations in semiconductors, applications, computers, communications equipment and devices, driving the next wave of technology investment.²⁰

In his exhaustive April 2002 report on “The Benefits of Broadband,” eMarketer analyst Ben Macklin details projections on the growth and economic value of services and broadband-enabled applications such as home networking, interactive TV, streaming media, telemedicine, online music, and e-business, among others.

In addition, greater usage of advanced Internet should help the economy more quickly absorb the extraordinary excess capacity that resulted from the technology spending boom of the late 1990’s. The great hope of the distressed telecom²¹ and telecom equipment sectors is that increased capacity in last mile networks will allow greater usage of untapped long-haul capacity and generate revenue opportunities through new services.

²⁰ The Pew Internet & the American Life Project survey reports that broadband users spend more time online, do more things, and do them more often than dial up users. Broadband users create more multimedia content and are more likely to look for technologies such as digital cameras, CD burners, etc. (Pew, Jul. 2002).

²¹ The telecommunications sector is particularly desperate to see accelerated broadband deployment. Telecom is mired in a serious downturn that some analysts blame for over 500,000 jobs lost and \$2 trillion in evaporated market capitalization, with broadband the only “bright spot” according to the Wall Street Journal. The sector suffers from extraordinary debt overhang – debts grew 165% while revenues grew just 50% from 1996-2000, according to the Precursor Group. Likewise, new wire less and data services are squeezing traditional carriers’ profit margins, while cautious VC and financial markets are virtually closed to telecom companies due to fears following the bubble and the WorldCom, Global Crossing, Tyco, Adelphia, and other scandals. And telecom and telecom equipment makers also suffer from extraordinary excess capacity, particularly following the boom and bubble of the late 1990s.

BROADBAND AND EDUCATION

ENABLING ANYWHERE, ANY TIME, STUDENT-APPROPRIATE LEARNING

New technologies are bringing hope and opportunity to those who need them most. We have just begun to scratch the surface of possibilities for using the Internet to improve learning and education, as 14 visionaries convened by the Technology Administration recently predicted. (See 2020 Visions: The Use of Advanced Technologies to Transform Education and Learning, Sept. 17, 2002). The more-than 200 Universities connected to Internet2 are experimenting with unprecedented collaborations among researchers and multinational, cross-continent classrooms. Congress’ Web-Based Education Commission reported in December 2000 that broadband connectivity is a critical element of using information technology to transform and improve education. And online education/training in the workplace is also growing extremely quickly and becoming increasingly sophisticated with widespread broadband in the business sector.

Rapid advancements in the years ahead could enable new learning environments that employ simulations, visualizations, immersive environments, game playing, intelligent tutors and avatars, networks of learners, reusable building blocks of content, and more. The technologies that are coming could permit rich and compelling learning opportunities that meet all learners’ needs, and provide knowledge and training when and where it is needed, all the while boosting the productivity of learning and lowering its cost. The Technology Administration is convening a summit on the potential for advanced technologies to transform education and learning later this month,²² and the experts clearly expect future innovations in learning technologies to ride and rely on high-speed networks.

²² On September 27, 2002, experts from industry, government and the education community will gather to discuss the investments, partnerships and technology developments needed to advance progress on innovations needed to advance education technologies. At the same time the Education Department is working on a National Educational Technology Plan – called for in the No Child Left Behind Act – to help plan how we’ll integrate these new technologies into education.

BROADBAND AND THE LIFE SCIENCES

TRANSFORMING HEALTH CARE

Broadband networks present enormous opportunities for life sciences and health care. More than access to medical information and online pharmacies, the real promise of telemedicine envisions citizens getting home check-ups without long drives and long waits, and anytime, anywhere diagnoses. Blood analysis devices in the home could permit online assessments of cholesterol and enzyme levels, anticipating problems before they require an ambulance. High-speed wireless connections could allow 24-7 monitoring of patients without confining them to hospital beds, while rural and remote doctors might be able to obtain second opinions from the world's foremost experts. Broadband-based applications such as robotic surgery and remote diagnosis could allow American doctors to answer the President's call for volunteerism by helping others in need around the world without leaving home.

In July 2002, the Technology Administration at the Department of Commerce hosted an expert roundtable to explore issues of innovation, demand and investment in telemedicine. (Innovation, Demand and Investment in Telemedicine Roundtable, June 2002). Experts advised that broadband-enabled telehealth applications offer opportunities to better prevent diseases and provide health care, empower patients and doctors, reduce medical errors, reduce costs and prepare for disasters, although significant policy, regulatory and coordination barriers must be overcome to achieve to more robust telemedicine usage. We hope to issue a more thorough report on telemedicine in the coming months, but one thing is clear – the most promising telemedicine applications need serious bandwidth.

We are already seeing the value of high-speed connections for biotechnology research. SRI observed in a February 2001 report on Knowledge-Management Tools that over 1,000 Merck & Co. scientists at four worldwide research sites tap into a bioinformatic database that contains four terabytes of data (expected to grow to eight terabytes in nine months). Don't try this with dial-up. Likewise, high-

speed access enables academic scientists to analyze genetic sequences for monthly fees under \$1,000. Before these applications were available online, the technology to analyze the sequences was only available to companies that could afford \$250,000 licensing fees, \$500,000 computer equipment and the staff to manage it. (The Industry Standard, May 29, 2000).

BROADBAND AND THE GLOBAL WAR ON TERROR

Broadband is also core critical to another of the President's top priorities – winning the global war on terrorism. Maj. Gen. Charles E. Croom, then vice director for command, control, communications and computer systems with the Joint Chiefs of Staff, identified the need for more bandwidth as the No. 1 technology challenge facing our military in Afghanistan (although these data communications now generally ride on wireless and satellite networks presently unavailable to average citizens). (Government Computer News, Jan. 2002). Broadband boosters should take hope from military efforts to develop and improve information technology systems, since applications created originally for defense purposes regularly become commercialized and available for civilian use (as did the Internet itself).

There may be no better example of an organization undergoing IT-enabled business process transformation than the United States military. Post-Cold War, Gulf War forces are becoming more mobile and more accurate – light and lethal – increasing effectiveness while decreasing the likelihood of U.S. casualties or civilian collateral damage. The technological core underlying these new systems – from unmanned reconnaissance aircraft, to data links among soldiers on the battlefield, to more efficient procurement systems – is a broadband data network.

BROADBAND AND HOMELAND DEFENSE

Broadband can also help enable homeland defense systems. Satellite-delivered broadband connections may permit real-time cockpit monitoring on aircraft, while high-speed access can provide local public safety workers with access to education and training videos created by Department of Homeland Security (DHS) and Federal Emergency Management

Agency (FEMA) and other expert organizations. Broadband-enabled video conferencing and business e-learning solutions could provide important productivity enhancements, allowing the same economic output despite reduced travel or more distributed organizational structures. Airport security officials will need fast connections to match passenger data against current biometric or national security databases. And broadband networks are the base upon which advanced knowledge management systems will rest, permitting greater coordination of health or intelligence information, so our experts can make use of real-time data to improve public safety.

BROADBAND AND NEW FREEDOM:

The high-speed Internet promises to extend new possibilities to those facing traditional limitations. A recent report for the National Association of the Deaf observes that broadband-enabled remote interpreting and peer-to-peer signing offer radical opportunities for the deaf. (Bowe, "Broadband and Americans With Disabilities," 2002). Likewise, a paper published by SeniorNet this year suggests broadband may have greater impact and significance upon American seniors than any other demographic group. (Adler, "The Age Wave Meets the Technology Wave: Broadband and Older Americans," Jun. 2002). For seniors, broadband can enhance communications with family and friends, expand opportunities for lifelong learning, improve delivery of health care services, support independent living, and create new options for entertainment and interaction with the government. And as video email messages replace written text on a true broadband Internet, communications opportunities may greatly expand for the millions of illiterate Americans presently challenged by text-based Internet communications.

WHAT DETERMINES OUR PACE?

LOW TAKE RATE?

With such extraordinary possibilities, robust broadband demand and usage seems inevitable. Yet many leaders understandably wish to accelerate broadband uptake to realize its benefits more

rapidly. To determine the best ways to accelerate broadband usage, one must understand the current market trends in broadband demand. Here's what we're seeing among consumers and businesses.

Some readers will take issue with the characterization of the take rate as "low." Many say the current broadband take rate compares favorably to that of other new technologies as they gained public adoption. But broadband reached a 5 percent take rate in three years, while it took cellular telephones seven years and television 10 years to reach that mark.

Adoption Time for New Consumer Technologies		
	Years to reach 10% adoption	Years to reach 50% adoption
Video Cassette Recorder	10	14
Compact Disc Player	4.5	10.5
Color TV	12	18
Cellular Phone	8	15
Personal Computer	4	18
Source: Federal Communications Commission, Robert Pepper presentation "Policies for Broadband Migration," April 2002		

Verizon noted that the pace of penetration of broadband has also exceeded that of pagers and video cassette recorders (VCRs). Some recent industry analysts suggest subscribership is increasing dramatically even though take rates appear low today; broadband subscriber-ship increased 250 percent nationwide for the 18-month period ending June 2001.

Hometown Computing said consumers were adopting broadband rapidly, and businesses will "get onboard as soon as they see a legitimate business need." Several commenters said higher take rates can be observed among households and businesses with computers and among households who were Internet subscribers, and this is more indicative of the perceived value of broadband.

Several articles by Onramp Access indicate said the state and the Nation are falling behind other countries with respect to the adoption of broadband. South Koreans are four times more likely and

Canadians are twice as likely to be broadband subscribers than Americans.

Several explanations for low take rates were offered; the top three reasons indicated cost, the lack of a “killer” application, and a lack of perceived value for broadband service offerings.

COST

The most obvious factor limiting broadband demand today is cost. An August 2002 survey by Yankee Group asking dial-up consumers why they were not upgrading to broadband networks found 72% of respondents complaining broadband was “too expensive.”²³ (“Revamping High-Speed Access Strategies: Tiered Services Hold the Key to Broadband Adoption,” Yankee Group, Aug. 2002). Many consumers fail to see the value proposition for investing in broadband, considering it a luxury they cannot afford or not yet worth the \$45-\$55 per month investment. Some consumers believe that broadband is a workplace technology with little value outside the office (and little interest in bringing work home). These sentiments appear to be exacerbated by concerns over price instability – 91% of all broadband providers (that did not go bankrupt in 2001) increased price since the beginning of 2001, by an average of 11.4% for DSL and 16% for cable (ARS research, May 2002). Remember too that roughly 40% of Americans have not yet seen the value proposition for subscribing to any Internet service, while almost 75% of dial-up Internet users in the U.S. reported being content with the quality of the service they use in a 2001 Parks Associates Survey. (Parks Associates, Nov. 11, 2001).²⁴

²³ Responses to a 2002 Yankee Group survey on why consumers were not signing up for broadband include:

- ✓ 72% said broadband was “too expensive”
- ✓ 12% said “installation is too complicated”
- ✓ 26% said they “cannot get high-speed access”
- ✓ 6% said “installation takes too long”
- ✓ 20% “don’t need” high-speed
- ✓ 17% offered “other” reasons

²⁴ In fairness, one must note that it is possible many consumers perceive greater price barriers than actually exist. At \$45 per month (average estimate), broadband may seem expensive. Yet dial-up consumers with a second line might only need to spend \$10 per month more to subscribe to broadband if they could cancel their current dial-up ISP and second telephone line.

In areas where broadband services are available, consumers may not be seeing a sufficient increase in value to justify the additional price of broadband over traditional dial-up Internet access. According to a recent survey, the average monthly price for cable modem service from CableVision in Flagstaff in early January 2003 was \$45 per month²⁵. The same survey indicated the average price of DSL was approximately \$52 a month. Ninety-one percent of broadband service providers that had been in business since the beginning of 2001 had raised their rates. Most consumers can purchase unlimited dial-up Internet access for around \$20 a month, or less. This means the additional annual cost for a family to migrate to a broadband connection is roughly \$300 to \$375, not including up-front costs for equipment or installation.²⁶

The competitive providers suggested that prices would drop if more competitors entered the market, a finding echoed by Dr. Mark Cooper. In his analysis, Dr. Cooper said the prices charged by the incumbent local exchange companies (ILECs) for DSL and cable operators for cable modem service are “driven by the raw exercise of market power.” He noted the incremental price to move to broadband from narrowband is considerably greater than the incremental price of moving to digital cable from analog cable, indicating that cable modem service “is not being priced to penetrate.” ILECs will seek to close their networks to competing companies and “leverage their monopoly telephone product with bundling, rather than compete on price,” he said. Dr. Cooper predicted cable companies and ILECs would never truly compete on price but would instead allow each other “to capture and hold the monopoly rents of different product markets.”

Onramp Access reported that the cost of broadband in the U.S. fares unfavorably to Canada, where broadband is more widely deployed and purchased.

²⁵ This price assumes the subscriber owns their own cable modem. Otherwise, the cost of service is ~\$55 with the leased modem.

²⁶ This cost does not include the cost of the basic telephone line which may be as high as \$37 per month. If the line is a “second” line for dedicated dial-up, differential cost between dial-up and DSL may be almost negligible - and well worth eliminating the second phone line for “always on, high speed” service of DSL.

Onramp indicated that retail DSL prices in the U.S. are 69 percent higher than in Canada, and wholesale prices are 25 percent higher. IP Communications said the ILECs and cable operators can charge a higher price “because the innovative competitive industry has not been sufficiently strong to discipline monopoly/duopoly pricing behavior.” Southwestern Bell said the requirements placed on ILECs to unbundle their infrastructure and provide it to competitors at discounted rates create “investment risks and uncertainty that make it difficult, if not fiscally reckless, to continue committing the enormous amounts of capital to deploy DSL.”

LACK OF “KILLER APPS.”

The absence of a compelling application for broadband was cited by most commenters as a reason for low take rates. The most common consumer uses of the Internet today—e-mail, web browsing, checking news and weather, shopping, and playing games—can be accomplished through dial-up access. Many of these were, in some form or fashion, the killer apps of dial-up.

“Unsettled digital copyright issues” and piracy may be holding back some of the content needed to spur broadband demand, but the “killer app” could well be something quite unpredictable and unforeseen. Onramp Access said states should foster an environment that makes it easier for innovators to bring their applications to the market.

LACK OF PERCEIVED VALUE

“Many customers simply do not perceive that the value added by broadband subscribership is worth current prices,” WorldCom said. Compared to the average \$600 per year price tag for broadband Internet access, many users are sticking with cheaper dialup connections, despite the “inconvenience” of dialing into the Internet using a relatively slow modem. Take rates are envisioned to increase once consumers are more educated about the response benefits of broadband access and its more sophisticated content.

A “fear of the technical hurdles that must be crossed to achieve and maintain broadband Internet access” may also reduce the perceived value is a frequent response. Problems faced by early ISDN, DSL, and

cable modem subscribers have created a perception that “broadband is hard.” Additionally, news stories about service quality problems, network outages, long waits for installation, and companies going out of business may be reducing the perceived value of broadband services.

CONTENT

Even if broadband were free, one should not expect to see 100% usage immediately, as is demonstrated by an experiment being conducted 65 miles southwest of downtown Atlanta. In LaGrange, Georgia, the city is partnering with Charter Communications to offer cable broadband access at almost zero cost for all interested consumers (including WebTV for those without PCs).

(Holsendolph, “A Georgia City Decided to Provide Its Residents With a Year of Free Internet Access. But Only Half Have Signed On: Why LaGrange Isn't More 'Wired',” Atlanta Journal & Constitution, Sept. 2, 2001). One year after first unveiling this offer, only 29% of citizens had subscribed (down from 49% during the period of heavy promotion). (Comments of Charter Communications to the NTIA, Dec. 2001). City leaders suggest barriers to greater adoption include reluctance to embrace change (often generational), lack of relevant local content, lack of reading ability, and lack of appreciation for the possibilities made available by broadband access. (It is also likely that some percentage of LaGrange citizens worried they would owe monthly payments after the period of free access ended).

It is worth noting that reluctance to embrace new technology is hardly just an American, generational or rural phenomenon. According to research from Computer Weekly reported in February 2002, 72% of UK consumers expressed no interest in paying for broadband Internet access. (NUA citing Computer Weekly, Feb. 2002). A study commissioned by the UK Department of Trade and Industry and Digital Content Forum determined that higher speed and lower prices alone will not be enough to ensure ubiquitous broadband demand. (DTI/DCF, Jul. 2001).

Content (including communications applications) is king. A majority of consumers will sign up for

broadband when value-adding applications and services are readily available, easily understood, and offered at reasonable prices. Wildly popular services and applications (“killer apps”) drove adoption of earlier technologies – e.g., fax machine (legal fax signatures), the PC (spreadsheets), and the dial-up Internet (email, web browser) – and they will be the key to accelerating broadband deployment as well.

The good news is that, for consumers, we already know some of these killer apps. Right now the most significant driver for consumer broadband adoption has been telework – the ability for consumers to work from home more readily. According to InStat/MDR, more than 60% of the US workforce is in remote locations, an enormous potential source for future broadband teleworkers. (InStat/MDR, Jun. 5, 2002). In a 2002 poll, the Winston Group found:

- 54% of Americans believe teleworking will improve the quality of their lives
- 66% believe telecommuting would help them strike a better work/life balance

A third of Americans would even forego a pay rise in order to work from home.

Online game-playing likewise promises to drive demand for broadband. Analyst Datamonitor forecasts that the online gamer market will grow from \$670 million in 2002 to \$2.9 billion in 2005. (Datamonitor, Aug 29 2002). Online gaming sites attracted more than 28 million visitors in the U.S. in April 2002, according to Nielsen NetRatings, and new broadband-based gaming consoles such as the X-Box are certain to increase consumer demand for higher speeds. (Nielsen NetRatings, May 22 2002). Even more compelling for consumers would be movies, music and games delivered online – entertainment on demand or interactive media.²⁷

²⁷ Consumers already have many secure, reliable and easy means for getting movies – from broadcast TV to cable to direct broadcast satellite to video rental stores. Movies will not drive broadband demand if they’re just one more (and less perfected) method for getting the same content. However, movie availability will accelerate broadband usage if the Internet offers either a lower-cost substitute for current entertainment access or adds value through interactivity, new options (e.g. virtual theater where multiple viewers see the same movie at the same time from

With an estimated 30-70 million unique visitors, the now-bankrupt file sharing service Napster demonstrated the viability of the Internet as a music distribution medium (and the enormous appeal of free music), driving demand for high-speed connections, faster computer processors, larger computer hard drives and CD-RW drives. More than 40% of home Internet users in the U.S. have already downloaded MP3 files onto their home computers, according to a new study by Parks Associates, while an analysis funded by the Motion Picture Association of America suggests between 400,000 and 600,000 movies are illegally downloaded every day, up 20% over piracy levels in 2001. (Parks Associates, Mar. 26, 2002 / Viant, “The Copyright Crusade II,” 2002). PriceWaterhouseCoopers forecasts that music and video-on-demand content will lead to greater adoption of broadband in the US. (PriceWaterhouseCoopers, Jun. 2002).

Unfortunately, sanctioned music and movie services have been slower to go and succeed online. In December 2001 and again in July 2002, the Technology Administration convened leaders from the IT, content and public interest sectors to encourage faster progress on bridging the gaps that are keeping so many movies and music from going online. (Digital Content & Rights Management Roundtables, Dec. 17, 2001 and Jul. 17, 2002). All panelists agreed that such digital entertainment would be major drivers of accelerated consumer adoption of high-speed connections if available online at reasonable costs and in formats consumers want (e.g. movies on TV instead of PCs). A majority of participants in December suggested that it would be a mistake for government to set mandatory technological standards for protecting digital content. Panelists mostly agreed that content creators can never expect a 100% piracy-free environment, and they cannot wait for an end to piracy before they venture forth.

There is considerable belief that creative, legal, for-profit sites can out-compete “free” alternatives. Industry will need to develop technologies that can protect digital content, ensure that legal services have the resources (breadth of content and range of

different locations while communicating with each other) or on-demand delivery.

devices) to out-compete illegal exchanges, educate consumers about the need to respect intellectual property on the Internet, cooperate across sectors and deliver content in ways and on platforms that consumers want (e.g. movies on big screens). Government will need to prosecute clear violations of the law, educate citizens about the importance of respecting intellectual property rights, facilitate and support market-determined solutions, and protect consumers' interests (such as fair use rights). There remains great hope that, as with the VCR or DVD, business models can be found that leverage new technologies and prove highly beneficial to artists and content creators.²⁸ (See "Downloads Did Not Cause the Music Slump, But They Can Cure It," Forrester Research, Aug. 15, 2002).

CONVENIENCE

In addition to concerns over price and (lack of sufficiently compelling) content, would-be broadband consumers express concern over deployment hassles and lack of plug-and-play equipment. Stories of dissatisfaction with service providers are legion, with some complaining that companies make you wait at home all day or require multiple trips to install the technology effectively. These inconveniences appear to influence narrowband consumers' decisions to not adopt broadband, and broadband consumers' spending decisions. In a 2002 study commissioned by Motive Communications:

- 51% of respondents using broadband claimed that they had encountered problems with service and support, such as having to contact a provider multiple times to get a problem solved or unacceptable delays in support.
- 90% of US broadband users said they didn't have enough confidence to purchase additional services from their current provider.

It is worth noting, however, that in the long-term, broadband access is likely to sell precisely because it offers greater conveniences for consumers. Home networking technologies, such as 802.11 wireless,

offer blockbuster appeal for entertainment and teleworking. Parks Associates found that over 50% of American Internet households are interested in networking digital entertainment content among PCs, TVs, stereos and DVD players. (Parks Associates, Aug. 2002). Of course the success of these technologies in driving broadband demand will depend upon their reliability, security, ease of installation, compatibility with legacy consumer electronics and consumers' continuing ability to attach them to the network.

CONFIDENCE

The fourth area most clearly impacting demand for higher-speed Internet access is consumer confidence. Consumers are concerned about privacy, security, SPAM and unsavory online locations – the dark side of the Net. Despite the fact that 99% of the most heavily trafficked Web sites post privacy policies (according to the Progress and Freedom Foundation), a June 2002 study from Jupiter Media Metrix indicated that almost 70% of US consumers worry that their privacy is at risk online. (Jupiter Research, Jun. 3, 2002). Consumer fears over security – including identity theft, hackers, fraud-artists and viruses – are even more pronounced. A July 2002 Gartner Research study found that 30% of those currently using the Web to shop on a regular basis said they would stop using the Internet for purchases if they lost \$25 [to fraud], while 58% of non-regular Internet shoppers said that a loss of less than \$25 would keep them from purchasing anything else on the Web. (eCommerce Times reporting Gartner, Aug. 2002).

Consumers are likewise deterred from greater Internet use by difficulties escaping the unsavory side of the Internet. Unsolicited email from adult-oriented Web sites increased 450% from June 2001 to June 2002 according to Cyber Atlas, and the omnipresence of these sites keeps some folks off the Internet entirely. The Radicati Group also estimates SPAM now represents more than a third of all email sent. (eCommerce Times, Sept. 11, 2002).

²⁸ Indeed, entertainment and news firms are venturing more aggressively online as the number of broadband users grows rapidly and technical ways to limit piracy appear to be effective. Multiple studios have initiatives underway with various business models and technologies being tried.

BROADBAND DEMAND AMONG BUSINESSES

As with consumers, businesses are steadily signing up for high-speed access and implementing broadband business solutions. Many businesses are using broadband to improve business processes or achieve efficiencies. Others are migrating to Internet-based systems to remain part of the supply chain of larger organizations that have moved their procurement systems online (such as automotive companies and retailer Wal-Mart). Telecommuting is driving significant business upgrades to broadband, according a September 2002 report to In-Stat/MDR, as businesses look for secure solutions to link remote offices and increasingly mobile workers. Yet as with consumers, several factors limit the pace with which companies are upgrading to broadband.

Similar to consumers, businesses are motivated by concerns over cost,²⁹ convenience / ease-of-use, and confidence in the security of online environments. With respect to content, there is arguably a richer array of business applications than consumer applications already out there. However, many businesses – especially small businesses – often don't understand or appreciate what high-speed Internet access is or what broadband applications can do for them. A National Federation of Independent Business (NFIB) report in 2001 suggested that:

- Broadband access is a necessary resource for small business to acquire soon even if they do not yet know this. But, small businesses are unlikely to recognize opportunities and threats posed by the Internet until they actually experience broadband service. (NFIB, "Broadband Internet Access for Rural Small Business," Jan. 2001).

In a 2001 poll of small businesses taken by NFIB, "feelings that high-speed Internet provides no competitive advantage outnumbers those who believe it provides a significant competitive

advantage by 6-to-1." (NFIB, "The Use and Value of Web Sites," 2001). In a different survey released in September 2002, TPG / eCom Ohio asked a cross section of U.S. businesses using dial-up Internet why they did not use broadband. (TPG / eCom Ohio, "Ohio and National Business Online Survey," 2002). The results:

- 29% reported no high speed service was available
- 23% said service was too expensive
- 21% suggested they were happy with their current access
- 13% reported they were not interested enough
- 8% said they never thought of it
- 3% said they had not gotten around to it
- 1% offered miscellaneous answers

This same TPG / eCom Ohio survey asked businesses about how they perceived the impact of Internet use on revenues and productivity:

- 64% of businesses predicted "no increase" in revenues
- 43% expected no increase in productivity.³⁰

These business awareness barriers were reiterated by experts at a March 25, 2002 roundtable held by the Technology Administration. (See "Broadband and Business Productivity," Mar. 25, 2002). Business leaders from NFIB, the U.S. Chamber of Commerce and the National Association of Manufacturers, among others, reported that companies often:

- Fail to see the return on investment (value proposition) for broadband upgrades, especially in a challenging business environment.³¹

²⁹ For many businesses, DSL and cable represent lower cost alternatives to T1 lines or existing high speed alternatives. For these businesses, lack of availability may be the top barrier to broadband usage.

³⁰ Although one must acknowledge that in the TPG / eCom Ohio survey, fully 75% of businesses believe the Internet will transform their business in the next five years. This means that while many businesses don't yet see the tangible impact on revenues or productivity, they do see it as a profound, transforming agent for their businesses.

³¹ Broadband demand among business is significantly impacted by changing attitudes towards capX / technology spending in the post-bubble, post-9/11, post-WorldCom world. After growth-centric years in which technology spending was seen as providing a competitive advantage enabling faster growth (in addition to greater productivity), businesses are now more likely to consider tech investments as costs impacting the bottom line. (Precursor

- Fear they lack skilled experts at the firm to manage the networks and run the applications.
- Need more strategic advice from their suppliers.
- Lack management commitment to the Internet as a key part of the business strategy.
- Don't perceive demand among their consumer base.
- Are concerned about security,³² privacy and other legal considerations.³³

connections to all Americans who want them, as soon as possible.

More than 20% of companies surveyed by In-Stat/MDR indicated they would not chose any type of broadband for their main office location, while 70% of respondents said "security" and "hosted applications" were key influencers for their firm's main office bandwidth requirements. (In-Stat/MDR, Sept. 11, 2002).

SUMMARY

For broadband, the sky is the limit and it's not falling yet. New applications and services that consumers want and businesses need will provide the tipping point for broadband demand and usage, especially continued improvements in communications applications. However, success in sustaining the Internet revolution as it moves from dial-up to mid-band to truly high-speed broadband will benefit from concerted effort and partnerships among federal, state, and local government as well as business leaders. Ensuring an environment that encourages capital formation and rewards risk – and letting the innovators innovate - stimulates the entrepreneurs to create jobs, companies and growth. It is in our nation's economic, national security and societal interest to have available robust broadband

Group). While the long-term winners will continue to invest aggressively in research and strategic technology upgrades, most businesses right now are looking for predictable investments with clear returns.

³² Internet attacks against public and private organizations around the world leapt 28% in the first six months of 2002, with most targeting technology, financial services and power companies, according to Internet security firm Riptech, Inc.

³³ Reuters recently reported a survey from a UK law firm that found more disciplinary cases have been brought against employees for violating email and Internet policies than for acts of dishonesty or violence. (Reuters, Sep. 3, 2002).

6

INITIATIVES, RISKS AND DISADVANTAGES

What to do ... and not to do ...

Before committing to any form of long-term strategy involving major investments in time and/or funding (especially if it involves *public* funding), it is worthwhile to understand the total picture of the broadband landscape and its customer base in order to mitigate risks. Metropolitan areas have in the past ten years accumulated a “fiber glut” that diluted the marketplace, and ultimately strangled many providers hoping to become major players in the telecom services market. Many of these companies failed largely because they all targeted - and “reused” - the same customer base as potential subscribers. This is highly unlikely in rural Arizona, largely because of the high cost of laying infrastructure into outlying regions.

The remainder of this Chapter will present for the reader a summary of a recent high-level summit intended to support the formulation of a long-term strategy on expanding broadband. While this summit was not held in Arizona, representatives from the top levels of government and industry were questioned in depth regarding:

- What options were available?
- What specific goals should be established (or avoided)?
- What methods could be used to measuring success?
- What role should the Private Sector assume?
- What role should the State play?
- What role should Communities play?
- What is the cost of “Middle-Mile”?
- Would a Broadband Map be beneficial?
- What broadband technologies are available?

- What success stories can be reviewed to support developing a Plan?

The following questions and answers were posed to key service providers and independent agencies at a Broadband Telecommunications Summit in Texas in early 2002 as a means of assessing strategic options. The following responses were provided annotated by whom.

QUESTION 1: OPTIONS FOR A STATE BROADBAND STRATEGY

What are the options a state can pursue to establish a workable broadband strategy?

We must first identify how broadband “fits into the state’s ... overall economic strategy” and then set policies and goals for broadband that help achieve this strategy. Actions to consider are (as recommended by):

- Allow the market to work out take rate issues through “creative marketing, pricing, and consumer education regarding the benefits of broadband” (AT&T).
- Remove policies that limit the ability of providers to invest in broadband infrastructure (Southwestern Bell).
- Foster a “free and open competitive market that gives providers an equal opportunity to meet customers’ demand where it exists” (1996 Telecom Act).

- Focus on “expanding competitive alternatives” to “drive down prices” and encourage innovation (CLEC Coalition, IP Communications).
- “Localize” Internet content by increasing the amount and quality of information about local events, weather, businesses, and government available on the Internet (Onramp Access).
- “Engender local leadership” to promote broadband applications in communities and bring together the “scattered resources” of communities into regional technology councils (Telecommunications and Information Policy Institute).
- Ensure that companies can bring their “killer apps” to consumers by preventing broadband providers from limiting the content or use of their broadband connections (Onramp Access).
- Remove barriers to bandwidth aggregation that prevent multiple users, such as different agencies of different levels of government, from taking advantage of broadband (County Information Resources Agency).

A number of these options could be used in concert, but some may be contradictory, if not outright mutually exclusive. For example, “expanding competitive alternatives” could require strengthening access and quality of service mandates on incumbent companies, which is precisely something that Southwestern Bell argues limits its ability to invest in broadband.

It is not recommended that any state pursue a path that commits large amounts of public funds and/or reducing regulations for the promise of “technological innovation that offers many opportunities to improve quality of life.” History has shown how promotion of the railroad led to wasteful spending by government on infrastructure that ultimately left “the citizens of many cities to bear large tax burdens but no local access to a railroad.”

Likewise, it is not advisable to establish policies that require investment into areas where demand does not exist or that “subsidize uneconomic business decisions.”

QUESTION 2: GOALS

Should the state adopt a set of policies (“state broadband strategy”) seeking the universal deployment of broadband when less than 10 percent of residences and businesses subscribe to high-speed Internet services in areas of the state where they are currently available? If not, what should the state broadband strategy seek to achieve? Should the state broadband strategy focus on the deployment of broadband, the take rate for broadband, or both? In what time frame should the state broadband strategy reasonably seek to achieve its goals? How should its success be measured?

Universal Deployment. The Coalition of Rural Cities said “a statewide policy is needed to address gaps in coverage, particularly in rural areas,” and this policy must “require deployment at rates and terms reasonably comparable to those in urban areas.” Hughes Network Systems (HNS) said the state should pursue a strategy of universal deployment because “the natural evolution of applications is such that inevitably high-bandwidth connectivity will be required.” Should this occur, then areas of the state that are not wired for broadband will be “too far behind to be able to recover,” said Integrated Economic Partnerships (IEP).

The state will have to challenge federal policy and industry trends if it seeks to declare broadband an important enough infrastructure project to require public resources. While saying that having an affordable, open advanced telecommunications network available to all Arizonans may sound prophetic, three reasons why embarking on such a policy would be premature include:

- The status of broadband service buildout within our information society is not yet clearly defined
- The industry is developing into a structure in anticipation of a “hands-off approach [that] poses an increasingly difficult challenge” to achieving universal deployment
- The FCC may be “on the verge of pre-empting virtually all state authority in this area, which may make most state policies futile.”

In other words, even if a state policy of ubiquitous deployment were desirable, it may not be achievable in any time frame. “The market not the government should ultimately determine the scope and pace of broadband deployment,” said Southwestern Bell, adding that a universal service policy does not make sense for broadband even though it does for basic dial-tone service. The state “should resist uneconomic investment mandates and arbitrary deadlines.” AT&T expressed the view that “a policy of universal deployment of broadband would be premature.” The state should instead focus on demand, not deployment, as at least one form of broadband is likely to be available in any part of Arizona. “A large-scale shift in public policy is not warranted,” wrote the CLEC Coalition. Instead, the state should continue to encourage competition by enforcing current law.

WorldCom said the states should not adopt a broadband strategy at all because “there is no indication of significant connectivity needs that cannot be met by other means.” Hometown Computing advocated letting the market develop on its own, adding that “any actions by the states will be more likely to hamper broadband than promote it.”

Alternative Goals: “A healthy competitive marketplace” should be the goal of a state broadband strategy, argued CBeyond Communications. This goal should be accompanied by enforcement of existing laws to “assist underserved areas of the state in securing access to advanced services,” said the CLEC Coalition. The state broadband strategy should focus on remedying “barriers to entry in the competitive broadband market,” and it should consider using tax benefits, subsidies, or low interest loans to encourage investment in new infrastructure.

AT&T agreed that a more limited approach would be best and supported the use of tax incentives to promote broadband deployment in areas where market forces alone have not been adequate.

Southwestern Bell agreed that tax credits and local use of economic development funds could help “offset the up-front costs of extending broadband.” Some think that the state should provide universal service funding for broadband infrastructure.

Whichever path is considered, any state incentives should be provided in a manner that ensures “investment is not totally out of proportion with the demand for the service.”

However, the CLEC Coalition said states should not “artificially stimulate demand” or encourage companies to make “investments that may not pay off.” Citing low take rates, Verizon argued “it may be disastrous to attempt to drive supply in the face of this small or nonexistent demand.” so it is worth warning that “subsidy mechanisms, such as Arizona’s Universal Service Fund, would thwart marketplace forces, disadvantage early investors, and inevitably would decrease free marketplace investment in broadband.” Several broadband providers said the state broadband strategy should remove disincentives to investment, focus on meeting local needs, be technology neutral, and avoid “locking in” particular technologies.

Hometown Computing said requiring government use of broadband would be “the most positive step the state could take.” For example, setting a goal of having every county courthouse wired with broadband within one year would be laudable. ORCA said the initial goal should be “to make access available at community access points,” such as schools, libraries, and senior citizens’ centers. This access should be combined with “layman’s language training and education opportunities.” Achieving this goal could ultimately spur demand as people learn about broadband and begin to use it regularly, ORCA said. TCTA agreed that the state should improve access for schools and libraries and provide increased exposure and training opportunities for students in rural and inner-city areas.

IP Communications said the state should be a leader in developing broadband content, such as playing live video feeds of open meetings. A state broadband strategy should also seek to coordinate various statewide telecommunications initiatives directed by several state agencies, said the Coalition of Rural Cities. It should not, however, prevent cities from exercising their duties to manage public rights-of-way and protect public health and safety, said TML.

Measuring Success. Few commenters provided measures of success or reasonable timeframes. WorldCom said the ultimate success of any strategy “should be measured by a customer’s ability to easily choose” another provider, much as can be done in the long-distance market. The County Information Resources Agency (CIRA) said a successful strategy would extend the Internet backbone to each county. Within a couple of years, at least 75 percent of counties should be so wired, CIRA said.

The Coleman County Community Network (CCCN) said it would expect it to take a year to develop the state broadband strategy, and its goals should be reached in three to five years. Success would be defined as having 25 percent of rural communities “connected to broadband and ... sustaining their projects.” Education Networks of America (ENA) said two to four years was a reasonable timeframe. Dynegy said the goal should be “reasonably priced access” within two to five years.

Verizon said the state “should not place an artificial timetable on market rollouts of broadband services” but should move forward as quickly as possible to provide “competitive parity” in broadband regulations. TCTA and WorldCom advocated not taking action on a state strategy until 2005, at which point the market will be more mature and the extent of unmet consumer demand will be clearer.

QUESTION 3: PRIVATE SECTOR’S ROLE

What is the private sector’s role in achieving a successful state broadband strategy? Who are the players, and what are they doing today? Which players are helpful in achieving the goals of the state broadband strategy, and which are not helpful? What, if anything, does the private sector have to do differently so that the goals of the state broadband strategy can be achieved?

This question sought both the self-perception of the private sector and an identification of which private sector entities should be considered within the mantle of a state broadband strategy.

Every commenter said the private sector’s role is to provide broadband services. “Only the private sector has the resources, the expertise, the local and regional workforce, and the access to capital to make and sustain” broadband services, wrote ORCA. Verizon said the private sector is the “risk-taker” that invests capital and builds networks based on the “perception of current and future demand, costs of deployment, and competitive business plans.” TCTA said the private sector’s role is “to attract broadband customers ... through investments in research and development, through marketing, and through education and training efforts.” HNS added that the private sector “can provide guidance and insight.”

TIPI said a collection of players broadly thought of as information service providers “has been responsible for the accelerated growth of networked communication.” These firms are “the source for new and innovative content, services, and applications that drive demand.” CBeyond Communications said the private sector’s role was to “respond with competitive offerings, thus bringing lower prices,” which will in turn “spur consumer demand.”

The Players. In general, commenters identified cable operators, wireline broadband providers, fixed and mobile wireless firms, and satellite companies as the principal private sector players. Several commenters also identified the Telecommunications Infrastructure Fund Board (TIF), makers of computers and modems, network equipment manufacturers, content providers, Internet service providers (ISPs), Internet backbone providers (IBPs), and the investment community. A few commenters said additional entities should be allowed to become players, including electric companies, municipal utilities, and local governments.

Several companies indicated they were providing broadband over more than one platform. For example, AT&T was deploying cable modem service through its cable systems and DSL through its purchase of NorthPoint Communications’ assets. AT&T had also experimented with fixed wireless, but “subsequently terminated that service for economic reasons.” Several commenters said developing technologies, such as Wi-Fi and other

wireless platforms, may have the potential to provide broadband services to consumers in areas where wireline deployment is uneconomical. These platforms may also provide competing services in markets where DSL and cable modem service are already available.

Virtually no one chose to identify parties who were being helpful or not helpful. Those few who did typically put ILECs and cable companies within the bounds of the latter.

Changes Needed. For the most part, commenters did not provide much additional guidance here. Clearly, the commenters believed the private sector needs to continue deploying infrastructure, developing innovative products and pricing plans, and searching for the “killer app.” The private sector needs to ensure that innovators can continue “to communicate with core network software ...[and] interconnect with and access broadband network infrastructure,” said TIPI. As such, telecommunications networks and cable operators should resist business models that “limit competition and innovation,” such as contracting with a single preferred ISP or engineering networks to allow selective “degradations in transmission quality.”

The private sector needs to be more of a partner with rural communities and “provide cash matches, assistance in sustainability, technical advice and assistance, expertise in marketing, and successful business planning,” said CCCN. TIF also suggested an increased role for the private sector to help “connect the dots” between public entities that are eligible for TIF funding and the private businesses and community institutions that may not have broadband access today.

In a different vein, Dr. Mark Cooper said each incumbent broadband provider “should stop pricing the service and withholding access in an abusive manner that exploits its market power.” Dr. Cooper said recent price increases for broadband services show a willingness “to forego sales to increase profits.” In short, he said the private sector needs to develop intramodal competition, lower prices, improve customer service, and offer more innovative services.

QUESTION 4: STATE’S ROLE

What goals of the state broadband strategy, if any, cannot be accomplished by the private sector alone and require the assistance of government? What actions should the state government take to ensure the success of the state broadband strategy? Are different actions needed to achieve success in rural areas than in urban areas?

This question follows the previous two by asking whether there is a gap between the goals of a state broadband strategy and the ability of the private sector to meet these goals in a timely manner on its own. In general, commenters envisioned some role for the state, and those roles can be broadly categorized as activist and minimalist in nature, though some commenters may disagree as to which they actually advocate. An activist role generally involves the intervention of the state to achieve its goals. A minimalist role generally involves the state allowing the market to develop on its own and stepping in only when the market fails to achieve desired outcomes. For the sake of discussion, the state’s current broadband policy would be considered as minimalist.

Activist Role. An activist position follows the general philosophy that the state has a “compelling interest in ensuring the development and maintenance of broadband communications networks that reach and serve all Arizonans in diverse and multiple ways.” Commenters advocating an activist role tended to be public, quasi-public, and community-based entities. Some non-incumbent broadband providers also advocate an activist role.

State as Mandator. A “mandator” position would say “the state needs to legislatively mandate deployment of broadband services in rural areas,” even in areas of the state where terrestrial providers deem broadband uneconomical. Such mandates would serve the “egalitarian provisioning needs of the state.” Most communities in Northern Arizona would agree that the private sector would not provide discounted broadband access to public schools and libraries without state mandates. However, the state should examine ways to allow the private sector to gain additional returns on its mandated investments by aggregating demand.

Onramp Access said the private sector cannot overcome the effects of “unregulated monopoly control [of] telecommunications in states.” Onramp Access suggested that the state regulate broadband companies and require deployment, or else create competition.

Looking back, the growth of the Internet arose in a regulatory regime where “information service providers were not regulated, but the core network infrastructure was.” This regime ultimately provided consumers with the variety of choices that are present in the narrowband market today. In that regard, the state might “apply the same successfully neutral structural policies to broadband networks” and mandate access for unaffiliated information service providers.

State as Networker. As a “networker,” the state should step in to fund infrastructure and find private sector partners for rural communities. Private sector companies cannot be counted on to provide needed infrastructure in rural areas, so these communities should build community networks and allow demand to “build naturally.” Once this occurs, the private sector may step in.

CIRA said the state should require demand aggregation and bandwidth-sharing among state and local governments. It should also foster public-private aggregation projects using a public entity as an anchor tenant.

State as Provider. As a “provider,” the state should “consider opening the state-administered network to rural and underserved areas” that are “less well served by private providers.” The Coalition of Rural Cities, TML, and the Texas Public Power Association (TPPA) said the state should allow municipally owned utilities to provide broadband services. TML said “a city may be the only entity interested in or capable of providing” broadband in rural areas. TPPA said the state should not enact a broadband policy that would “diminish the ability of municipalities or municipally owned electric utilities to provide telecommunications services under current law.”

State as Investor. As an “investor,” the state should provide “ongoing incentives for financial sustainability until such time as the use of

broadband becomes as common as the telephone or electricity for the everyday user,” said ORCA. TLA and TSLAC said the state should subsidize the cost of providing broadband to rural areas, public institutions, and residents in low-income urban areas.

An aggressive state role would be appropriate if broadband availability were to be considered an infrastructure issue, said Dr. Mark Cooper. Infrastructure projects often involve large-scale investments typified by huge upfront costs, strong positive externalities, and lower-than-desired returns on private investment. The state can support such a large project—short of building it itself—through loans, grants, tax incentives, franchises, and condemnation power, all with a public interest obligation attached. However, “given the ambiguous legal status of broadband services, it would be easy for the state to spend a lot of resources encouraging deployment of facilities and end up with very little in the way of binding commitments to the public policy goals” justifying the spending of resources.

Minimalist Role. A minimalist position suggests a state policy of allowing the private sector to develop the broadband market in a largely unregulated environment. The state engages in small initiatives, such as expanding its own use of broadband, but otherwise allows deployment and competition to develop on their own. At most, the state enforces current laws aimed at ensuring access by competitors to broadband networks, although several broadband providers advocated an even smaller state role. Commenters advocating a minimalist role were typically broadband providers and related private sector entities.

State as Demand Creator. As a “creator,” ENA said the state should encourage the use of broadband by expanding educational use of computers, increasing the use of telecommuting by state employees, and promoting online government services such e-filing or other e-transactions. TCTA agreed that the state should spur the use of broadband by public schools and government offices and expand the online delivery of government services.

State as Referee. The American Electronics Association (AEA) said the state “should act as an

independent, third party arbiter” that largely allows the market to work and only steps in to help consumers where “disparities may arise.” AT&T said the state should “ensure that competition continues to develop by assuring that competitors have access to essential facilities controlled by incumbent local exchange companies.”

Table X. Estimated Tax Rate on Telecommunications Service

1. Texas	28.56%	27. Mississippi	14.40%
2. Florida	24.47%	28. Tennessee	14.25%
3. Nebraska	24.15%	29. Louisiana	11.60%
4. Missouri	23.79%	30. Iowa	10.50%
5. Colorado	23.70%	31. Oregon	10.25%
6. Oklahoma	21.71%	32. Ohio	9.75%
7. Pennsylvania	21.46%	33. Arkansas	9.67%
8. New York	21.33%	34. South Dakota	9.32%
9. Maryland	20.92%	35. Minnesota	8.87%
10. Kansas	20.59%	36. Alaska	8.57%
11. Alabama	19.89%	37. New Mexico	8.15%
12. Kentucky	19.70%	38. Wyoming	8.01%
13. Illinois	19.51%	39. Nevada	8.00%
14. Virginia	19.09%	40. Delaware	7.97%
15. Washington	19.05%	41. Connecticut	7.42%
16. Georgia	18.98%	42. New Hampshire	6.98%
17. North Carolina	18.50%	43. Indiana	6.35%
18. South Carolina	18.32%	44. New Jersey	6.25%
19. North Dakota	18.24%	45. Montana	6.21%
20. Utah	18.09%	46. Hawaii	6.14%
21. Rhode Island	16.95%	47. Michigan	6.00%
22. West Virginia	16.32%	48. Vermont	5.81%
23. Wisconsin	16.07%	49. Maine	5.50%
24. California	15.99%	50. Massachusetts	5.09%
25. D.C.	15.75%	51. Idaho	4.94%
26. Arizona	15.34%		

Source: Joseph J. Cordes, et al., “The Tangled Web of Taxing Talk” (September 2000). State and local taxes and fees are calculated as a percent of an average residential bill.

State as Encourager. As an “encourager,” several commenters said the state may need to step in to address market failures that may occur, especially in underserved areas of the state, where broadband services cannot be economically deployed. The typical answer to this problem was targeted tax incentives to lower the cost of deployment in these areas. However, these commenters do not believe

that market failure is a certainty and thus do not advocate immediate state intervention.

State as Leveler. South-western Bell said the state should develop a technologic-ally neutral policy that would “prevent or remove artificial barriers impeding further broadband investment.” Regulations “only increase the cost and risk” of deployment. TTA said the state should “facilitate the acquisition of rights-of-way for the installation of new broadband facilities,” remove regulatory barriers, and create incentives to invest.

Any tax reductions or incentives for investment should be provided in a competitively neutral manner. Hometown Computing said broadband will continue to be deployed and competition will develop “as long as the state does not take action to stop the rollout of broadband, such as subsidizing a specific provider.” The state should periodically review all of its laws and regulations to ensure consistency with the current state of the competitive marketplace.

QUESTION 5: COMMUNITY’S ROLE

What is the proper role of the community in achieving a successful state broadband strategy? Should the state broadband strategy include the participation of local governments, local economic development corporations, nonprofit entities, councils of government, school districts, community college districts, other special districts, libraries, or other public or private nonprofit entities? What should be the specific roles of these types of entities?

This question sought to define the role of the community, which was broadly conceived as the citizens and businesses of a particular geographic locality and the various public or public interest entities located there. It was noted that each of the specific entities named have their own roles to play in a community, but a coordinated effort among them may be the key to spurring broadband deployment.

Several themes emerged from the responses, and collectively these themes could describe the community’s role in a state broadband strategy. Broadly, communities can:

- Supply the leadership needed to build collaborations, acquire broadband services, sustain those investments, obtain needed expertise, acquire subscribers, and educate citizens.
- Assess the community's broadband needs and determine the extent to which the community's institutions (schools, libraries, government offices, and businesses) are already being met.
- Aggregate demand for broadband, or otherwise demonstrate that demand exists, to spur deployment by the private sector.
- Develop local Internet content, place local government and school information on the Internet, and encourage government's use of electronic communications to citizens.
- Educate citizens about the availability of broadband access points already within the community and about the benefits of broadband connectivity.
- Remove any barriers to competitive carriers for access to public rights-of-way.
- Provide subsidies, tax incentives, economic development funding, ease right-of-way restrictions, and other incentives to reduce the cost of broadband deployment.

Although no one noted it, another role of communities is to purchase broadband services to meet local needs. Where commenters differed was on the question of whether communities should be able to provide broadband themselves. Some commenters representing cities, communities, and certain public entities believed that the prohibitions against cities providing telecommunications services should be lifted. In particular, the Coalition of Rural Cities said municipal utilities should be allowed to provide broadband to their customers, and electric cooperatives were also mentioned as a possible provider in certain areas.

Broadband providers were opposed to municipal entry into the broadband business, except "as a last resort," when no private sector company would step forward to meet a community's demand. In such cases, AT&T said economic development corporations and local governments should be "empowered to obtain these services." Southwestern Bell said any cities that became broadband providers should be held to the same rules and

requirements of private companies. TCTA agreed that cities should not enter the broadband business, but if they do, they should follow code of conduct rules in place for municipally franchised cable operators.

QUESTION 6: ROLE OF AN "INFRASTRUCTURE FUND"

As of the end of 2001, the Telecommunications Infrastructure Fund Board (TIF) had issued grants totaling \$920 million to public schools, libraries, universities, health science centers, not-for-profit healthcare facilities, and community networking initiatives. Under current law (in Texas), collection of the TIF assessment (currently 1.25 percent of taxable telecommunications receipts) ceases once TIF collections reach a cumulative \$1.5 billion. Should TIF continue to play a role in the state broadband strategy? If it has a role to play, how should its mission be expanded or changed to achieve the state's broadband goals? How should TIF be funded?

TIF was created as part of Texas House Bill 2128, 74th Legislature, which significantly overhauled the regulation of the telecommunications industry and marked the advent of local competition. The TIF assessment is currently applied to wireline telecommunications utilities, including inter-exchange carriers (IXCs), and wireless providers. Funds collected through this assessment are split evenly into two accounts. The Public Schools Account is dedicated solely to K-12 public school districts and campuses. The Qualifying Entities Account is dedicated to K-12 public school districts and campuses, colleges and universities, libraries, academic health centers, and public or not-for-profit healthcare facilities. Under current law, collection of the TIF assessment will cease at the end of fiscal year 2004, which is the year before the Sunset Commission's recommendations regarding TIF will reach the Legislature.

This question sought opinions as to how, or whether, the TIF fit into a state broadband strategy, either as part of broadband legislation in 2003, or the sunset review process in 2005. Respondents reported varied levels of satisfaction with the TIF's performance and even more varied opinions as to whether, and in what manner, it should continue.

Several commenters pointed to specific instances where TIF funding has been instrumental to achieving goals. For example, CCCN declared TIF funding “the only source for rural areas to expand into the 21st century.” TIF has been able to leverage its grant money and statewide coverage to fund a series of information resources that individual libraries could not afford on their own, TLA said. This information sharing program, called TexShare, was paid for by a \$10 million TIF grant. If bought separately by each library in the state, these resources would have cost \$150 million.

Most commenters seemed to believe that TIF had largely completed its current statutory role, which was to fund the infrastructure necessary to connect eligible entities to the Internet. Several commenters noted that any extension of the TIF must fit into a state broadband strategy. The creation and implementation of TIF’s grant programs were done without any state broadband strategy, and it resulted in “a patchwork of available technology and telecommunications equipment that begs for the connectivity into a much broader constellation of broadband,” said ORCA. A number of commenters suggested the need for TIF continues beyond its initial statutory mandate and lifetime.

In general, broadband providers opposed the continuation of TIF, at least as it is presently financed. TTA called the TIF assessment “an industry-specific corporate tax” that was created to fulfill a narrow public policy purpose. Verizon argued that the assessment is “anti-competitive and ultimately undermines” broadband deployment, as it is not assessed upon the majority of broadband providers. Once the original statutory purpose is fulfilled—TTA said TIF has been “largely successful” in achieving its original purpose—then TIF should end, TTA argued.

Southwestern Bell said the costs of a broader deployment beyond current TIF-eligible entities would be “mind-boggling,” and it agreed with TTA that TIF has largely completed its statutory mission. TSTCI said TIF was not structured to achieve universal broadband deployment, and any changes in its mission toward this end would require “a major overhaul.” These would include broadening the funding base, allowing ILECs to pass the assessment through to customers, and requiring future grants to be both “technology and carrier

neutral,” said TTA and several other broadband providers. However, AT&T (as both a CLEC and IXC) demonstrated support for continuing the TIF beyond 2005, noting “TIF continues to help address the increasing technological needs of schools, hospitals, and libraries.”

Also opposing continuation is Hometown Computing, a rural ISP operating out of Hamilton, Texas. Hometown Computing said the infrastructure TIF funds “already exists,” and the money spent by TIF “does not benefit the community greatly.” Several other commenters said the private sector would be a better provider of community networking than a state-supported grant process. These commenters suggested that TIF grants effectively remove the incentive for private investment in these communities.

Changes to Mission. TIF’s mission has largely been one of providing the “boxes and wires” and training needed to establish connectivity for its eligible entities. Recently, it has begun to examine the sustainability of its previous grant awards and create collaborative projects, such as its Community Networking grants. Through its working groups, TIF is currently conducting comprehensive needs assessments to determine its eligible entities’ ongoing requirements.

When TIF was created in 1995, “the high-speed service offerings available in the marketplace looked very different than they do today,” said TCTA, adding that the combination of TIF grants and statutory discounts has the effect of encouraging eligible entities to purchase “more expensive, subsidized services ... that may exceed their capacity needs.” Any proposed change in TIF’s mission should include an examination of the effects of these statutory requirements and also account for changes in the broadband marketplace that have occurred since 1995, said TCTA.

TIPI said TIF is “well positioned to play an important role in coordinating the development of a broadband strategy,” but only if its mission moves beyond the limited connectivity it has provided over the last several years. Specifically, TIPI identified four features of a new TIF mission:

- Evaluate network efficiencies;

- Integrate the telecommunications infrastructure serving the public sector;
- Create metrics for benchmarking service quality throughout the state; and
- Coordinate training needs and opportunities for continuing education in using new technologies.

Other commenters suggested that TIF should focus on using its grants to leverage additional private investment by promoting collaborative grants and extending connectivity beyond eligible entities. TSLAC said it supports the dedication of future TIF funds to the goal of “ubiquitous access” to broadband.

Expansion of Eligible Entities. CCCN said the list of entities eligible for TIF should be expanded to include community action agencies, nonprofit organizations, Head Start programs, housing authorities, economic development corporations, chambers of commerce, alternative schools, and rural state government offices. CIRA said eligibility should be extended to municipal and county government offices. TML said the potential role of cities in expanding broadband availability should also make them a potential candidate for TIF eligibility.

Sustainability. “Connectivity is not a one-time cost,” said TLA. “Many of the institutions assisted by TIF will not be able to maintain connectivity without assistance.” Sustainability includes not only the hardware and connection charges but also the software and training needed to make use of the connectivity, said TLA. Several other commenters noted that the availability of training and information resources would be diminished without continued funding, especially in rural and isolated areas.

Targeting. ENA said TIF should focus its grants on “outcome-based projects that produce measurable results in educational effectiveness.” IP Communications said TIF grantees should be expected “to share access in their communities,” and TIF’s grant programs should be tailored to broader policy goals that will connect more than the current list of eligible entities. ORCA agreed that TIF should stimulate the creation of connections between the investments it has already made in the community at large, and it should collaborate with

other state agencies to develop broader strategies for communities that are awarded grants. CIRA added that TIF should work to bring the Internet backbone closer to rural communities as a way of reducing middle mile costs.

Simplification. TSLAC said TIF’s “procedures for awarding and distributing grant funds are unlike anything else in state or federal government.” Specifically, the commission said the TIF has the following deficiencies:

- Forms are onerous to complete
- Instructions are often contradictory
- Reports submitted by grantees appear to have little use, and
- Funds are not made available until after the work has been performed and the equipment ordered.

Onramp Access also expressed frustration at the “daunting” application process. As an example, Onramp Access said it currently provides free Internet access to the Liberty Hill library, but there is little incentive for the community there to apply for TIF funding to extend that connectivity to other users. Several commenters said the administrative costs of applying for the grants and producing required reports can outweigh the grants’ benefits. Onramp Access recommended that TIF could simplify the process by developing packages of products that communities could simply choose to apply for.

Funding Sources. Most of the respondents who were not being charged with the current TIF assessment expressed the belief that the current assessment should continue beyond its statutory termination, as is.

Some respondents said the assessment should be adjusted to account for changes in the TIF’s mission, especially if that mission or the list of eligible entities were to be expanded. TLA said the current assessment meets the “ongoing (and evolving) needs” of current TIF-eligible entities and implied that there would not be enough money for all purposes if TIF’s mission were expanded.

ORCA said that a large portion of the TIF grant money was returned to the carriers in the form of fees paid for telecommunications services. The extent to which carriers were essentially able to recover their assessment is not known, ORCA said. TIPI added, “the widespread availability of telecommunications capabilities in the state ultimately is in the best interest ... of its telecommunications vendors.” TIPI implied that TIF’s investments could ultimately be leveraged by the providers into profitable connections. TLA thought the benefits accruing to telecommunications companies should be considered as part of the funding question. Several commenters, including TLA, added that all carriers should be allowed to pass any assessment through to their customers. The CLEC Coalition argued that “TIF funding should come from all Texans, not merely from users of telecommunications services.” Several broadband providers that oppose continuing TIF echoed this concern, adding that any future funding mechanism must apply to all broadband providers equally. Southwestern Bell said “significant disparities already exist among competitors regarding the ability to recover current TIF assessments.” Any carrier subject to any future assessment should be allowed to pass that assessment through to their customers.

TTA, Verizon, and others argued that funds for expanding the TIF mission should come from general revenue. However, if an industry-specific funding stream were maintained, then it should be assessed on “all players in the broadband marketplace, including manufacturers of computer goods and services, ISPs, and all providers,” said Verizon. Several commenters noted that the assessment should be reduced to account for the larger taxable base over which it could be applied. TIPI said an alternative source of TIF funding could come from reassigning the current touchtone service fee to TIF. The fee “is outmoded technologically and indeed has been eliminated in certain states,” TIPI said.

In addition to state funding, TML said the state should provide expanded options for local governments to promote broadband availability, such as:

- Allowing economic development corporations to spend their revenues on broadband-related projects
- Authorizing cities to hold an election to dedicate local sales tax revenue to broadband-related projects (assuming the locality is not already at its sales tax cap)
- Providing for an optional local property tax exemption for broadband infrastructure
- Enabling municipalities to grant franchise fee abatements for broadband deployment
- Including deployment of broadband as a specific purpose for which a neighborhood empowerment zone can be established.

Several of these options were considered by the committee and included in the committee substitute to Senate Bill 1783, 77th Legislature.

QUESTION 7: MIDDLE MILE COSTS

A recent National Exchange Carrier Association (NECA) study concluded that “middle mile” costs—the costs of transporting Internet traffic from rural Internet Service Providers to an Internet Backbone Provider—make high-speed Internet service uneconomic in many rural areas. Further, the study warns that middle mile costs could actually increase as take rates increase in many rural areas. Are NECA’s conclusions valid? If so, how and by whom should this problem be addressed?

Most of this state’s efforts in developing broadband policy have focused on the last mile and the problems faced by rural communities in obtaining this infrastructure. Middle mile costs have largely escaped the attention of policy-makers, yet they may be more crucial to understanding the problems of deployment in rural Texas than last mile issues. This question sought guidance on the impact middle mile costs may have on broadband deployment.

While many commenters said middle mile costs were a problem, few conveyed the extent to which this problem actually inhibits broadband deployment or identified potential solutions. Part of this is the limited research available on the topic. Unfortunately, the NECA study was never

published on the Internet or otherwise made freely available. As such, most commenters did not have the benefit of reviewing the study before answering the question. Consequently, many commenters had no opinion about the study and its specific conclusions. In addition, several independent efforts to quantify the scope of the problem were hampered by the dizzying array of possible combinations of tariffs and fees.

Hometown Computing, a rural ISP, said middle mile costs are “a huge problem which has gone unnoticed by most people.” Hometown Computing said the rates for middle mile transport vary widely across its service area, to as much as \$40 per mile, and in most cases this transport can be purchased only from a single provider in any location. The PUC should investigate the price variations, Hometown Computing said. Onramp Access, another ISP, said high middle mile costs are “the primary factor inhibiting the delivery of broadband access to rural communities.”

Onramp Access suggested several potential solutions that the state could employ, including: Setting a regulated rate for middle mile transport at no more than 125 percent of the prevailing market rate in urban areas.

Developing a statewide Internet backbone that extends the edge of the network closer to rural cities, thus reducing distance and cost. Allowing entities such as the Lower Colorado River Authority (LCRA) to provide wholesale transport over their fiber.

Encouraging more “peering points,” which are interconnections between which providers, or peers, trade data traffic.

Onramp Access said the state should keep its eye on the quality, service, and terms of conditions in addition to price. In other words, the state should not allow a middle mile provider to offer superior quality service to its own affiliates.

The CLEC Coalition said the economics of geography and density of subscribers make it more difficult to recover the cost of higher capacity transport in rural areas. This would lead to higher per-user costs, if the middle mile provider were to

recover its costs in a manner that makes investing in the transport infrastructure worthwhile. TIPI said that any approach that keeps traffic local will reduce costs, and the state should establish more peering points so that less data would need to be transported to the Internet cloud.

AEA questioned the study’s conclusions given that “there currently exists a capacity glut and prices have fallen to the point where [Internet backbone] providers are concerned they will not recover their investment costs.” TCTA said middle mile transport is “priced with no competitive pressures,” but noted that there are a “growing number of innovative niche providers” that are beginning to compete with ILECs.

CCCN said subsidies should be provided to reduce middle mile costs for rural areas. Southwestern Bell cautioned the state not to require ILECs “to bear the entire subsidy burden” or provide “steep discounts” to certain classes of businesses, notably ISPs, similar to those enjoyed by certain public entities.

QUESTION 8: BROADBAND MAP

Would it benefit the state broadband strategy to develop a graphical inventory of public and/or private high-speed infrastructure within the state? If so, what types of high-speed infrastructure and/or services should be included in the graphical inventory? Which players would need to participate for the graphical inventory to be useful?

Several broadband providers said a map or other similar data base would not be useful. Other commenters said a map could be useful in developing policy or assessing needs. AEA said a broadband map “can assist the state in determining which areas or demographic groups are disproportionately underserved.” Though TCTA said it could not see “any particular benefit” to a map of infrastructure, it nonetheless may benefit the state to establish a map of service offerings by locality, such as the Ohio E-Com project.

TIPI said any map should capture backbone and last mile facilities, including DSL, cable modem service, fixed wireless facilities, and dedicated lines.

Backbone facilities should include points of presence (POPs), Internet peering points, and LATA boundaries. TSTCI said the state should use the data that is already available before embarking on a new data gathering project.

Hometown Computing said that any broadband map “would be out-of-date before it is printed.” Furthermore, consumers should not need to rely on a state-run broadband map to see if service is available there. “If broadband exists in an area and consumers don’t know it, the provider needs a new marketing manager,” Hometown Computing said. Several carriers said participation by the private sector should be voluntary, and any mapping project should take care not to compromise network security or divulge proprietary information.

IP Communications said the Texas Open Records Act should be amended to guarantee the confidentiality of any proprietary information that may be used to build the map. Any mapping project should begin with the plotting of state infrastructure and the broadband investment of public entities, such as the LCRA, said several commenters.

AT&T said a broadband map may be unintentionally misleading because “the mere fact that infrastructure is present does not automatically mean that it could be used in connection with the development of a particular broadband network.” The Legislative Rural Caucus said a map could help policy-makers evaluate the presence of broadband infrastructure and be an effective tool in developing a state broadband strategy. Consistent with these comments, the committee embarked on a project to map broadband service offerings.

QUESTION 9: BROADBAND TECHNOLOGIES STRATEGY

How should the state broadband strategy address technical and business differences between broadband technologies, including DSL, cable modems, wireless platforms, and satellite? How do these different technologies contribute toward the success of the state broadband strategy? Should the state broadband strategy seek to establish (or enhance) competition among providers of the same

technology or between technologies? Should the state broadband strategy have different goals for competition in urban areas than in rural areas?

This question addresses the need for a state broadband strategy to recognize significant differences in network architecture, regulatory authority, geography, and competitive potential. In a sense, all of the foregoing questions dealt with broadband as a capability rather than as a series of technologies with different applications and potential for use. This question asks commenters how a strategy should be adapted to account for these differences. Their answers touched on a number of federal and state regulatory policies that are discussed in detail in subsequent sections of this report.

Technological Neutrality. Virtually every commenter said a state broadband policy should be technologically neutral, although few commenters provided much guidance on how neutrality would be legislated.

TCTA said the state “should leave the technical and business differences between broadband technologies to be addressed in the marketplace,” an opinion echoed by many commenters. “By focusing on the demand for broadband services,” said AT&T, “the state’s broadband policy would be technologically neutral.” Demand is not dependent upon a particular kind of technology but on whether consumers have computers, whether broadband service is available, and whether such service is fairly priced and reasonably reliable. Southwestern Bell commended the PUC for its advanced services rulemaking, which it described as a “technologically and competitively neutral policy that acknowledges the diverse geographical needs of the state.”

Verizon said the state broadband strategy should “strive for competitive parity between different technologies ... as well as differing classes of carriers within a particular technology.” TSTCI said it was important for the state to set “service quality goals and standards for speed,” but it should not specify the type of technology required. Commenters representing libraries said the state broadband strategy should stress interoperability between platforms so that content, such as data

bases developed using the Z39.50³⁴ search and retrieval standard, may be used by any citizen with any broadband connection. Several commenters said interconnection remains an important aspect of the state's policy.

Framework for Competition. TCTA was one of several commenters which said that both intramodal and intermodal forms of competition are needed in the marketplace. While "the success of today's broadband marketplace is directly attributable to ... intermodal competition," the competition between ILECs and CLECs offering DSL service over the public switched network has also been an effective force driving deployment, TCTA said. Verizon added that the state should "encourage facilities-based broadband deployment, regardless of technology." The state should do this by reducing obstacles to facilities-based deployment, achieving a "level playing field for all providers," and letting the marketplace "determine the most efficient provider(s) for each area," Verizon said.

AEA said the state should encourage intermodal, facilities-based competition in which "no one market participant controls essential facilities or has the ability to create a bottleneck." The "limited benefits" of intramodal competition "cannot be maintained without strong regulatory oversight that may have unintended consequences," AEA said. Southwestern Bell said the state should avoid policies that "pick winners and losers through application of uneven rules and regulations."

Dr. Mark Cooper warned that "the presence of multiple technologies in the broader market will be mistakenly assumed to represent head-to-head competition in local markets." Because of technological differences between broadband platforms, "they are not likely to compete head-to-head in many markets." Onramp Access said not all

technologies available to a particular customer are especially suitable for their needs. A lack of intramodal competition could leave such customers to be served by virtual monopolists.

The CLEC Coalition said intermodal competition "is not sufficient to drive prices down and innovation up." By encouraging intramodal competition, "Texas stands the best chance of developing a marketplace that delivers the most benefits from the broadest number of players."

AT&T said the state should continue to provide competitors access to the ILECs' essential facilities because "competing providers of DSL help ensure that consumers have the option of choosing the provider with the best customer service." Absent competitive pressure, a provider has no incentive to improve service, AT&T said. TCTA added that the presence of competitors will "promote customer awareness of broadband services." WorldCom said the state should not embrace deregulation of wireline broadband on a belief that doing so "will somehow incent the incumbent local exchange companies to invest more in broadband technology."

Rural and Urban Considerations. Most commenters either did not address the issue of whether the state broadband strategy should have different goals for rural and urban areas or declared that a technologically neutral strategy would by its nature address geographic diversity. Commenters representing rural areas said the state should recognize the unique needs of these communities and develop a flexible strategy that could meet those needs.

Competition in rural areas may not be a possibility because of geography and population density, said ORCA. Thus, the state broadband strategy should be able to reach a goal of "reasonable access to high speed bandwidth at a sustainable cost and efficiency," even if there is only one potential provider. TTA noted that competition in rural areas is often not sustainable in many business sectors.

³⁴ The Z39.50 search and retrieval standard is a computer-to-computer protocol that allows individuals using one computer system to search the resources of another computer system without needing to know the particular search syntax of that second system. In other words, all a person needs to know is how to use their own computer system, and the protocol will translate their familiar search syntax into the input needed to operate the other system. It is an international standard that was adopted by the National Information Standards Organization in 1988, and it is the standard used by the Library of Congress.

QUESTION 10: SUCCESS STORIES

Are there particular “success stories” that the committee should look to in crafting a state broadband strategy? Please consider both rural and urban areas, as well as the policies and successes of other states or nations.

A number of commenters supplied examples of broadband successes for the committee’s consideration. They are presented here in no particular order.

“Cable in the Classroom” is a national public service effort on the part of the cable industry that provides schools with free cable connections and commercial-free educational programming.

TCTA said more than 3.4 million Texas students in approximately 5,500 schools have access to these services. AT&T said it also provides free cable modem service to every school and library within its cable service territories. TCTA said cable operators have been able to take advantage of “clustering,” whereby several cable systems can be linked together to share broadband connectivity, to bring high-speed Internet access to 40 communities in the Rio Grande Valley. Similar projects are underway in the Corpus Christi and Beaumont/Port Arthur areas.

TCTA also pointed to PowerUP, a national organization aimed at helping young people succeed in the digital age. AOL Time Warner has provided 100,000 free online accounts to the PowerUP program, and Time Warner Cable is committed to providing free cable modem service at PowerUP sites within its service territories. The AT&T Foundation has partnered with the National Association for the Advancement of Colored People (NAACP) and the National Urban League to build community technology centers, including new centers in Houston and Dallas, that provide inner-city communities with technology-skills training.

The Coalition of Rural Cities said several municipally owned utilities are providing Internet access to their customers. Greenville Texas Electric Utility Systems has deployed its own cable/broadband network and 20-mile fiber optic

network, and it began offering cable modem service at about \$40 a month in July 2001. Floresville Light & Power Systems provides dial-up Internet access and dedicated lines to customers in its service territory. The coalition said that about 450 of the 2,014 public power systems nationwide offered some form of broadband service.

ORCA said state grants have helped connect the schools, hospital, library, and various other sites in the town of Cuero. More than 1,000 residents have been trained in the use of technology and library resources, and students are able to check out notebook computers which they can use to access the wireless network from home. Telemedicine services are being utilized at school nurses’ offices and local physicians’ practices. Cuero has even converted an old school bus into a traveling computer lab.

Representative Jim Keffer said the Eastland County Community Networking project is an example of a wireless networking business model that could be successfully adopted by other rural communities. Five communities have banded together to coordinate a county-wide networking effort, which will be overseen by a non-profit organization. Any ISP may use this network to offer high-speed Internet access service. Representative Arlene Wohlgemuth said Texas Unwired Networks has brought broadband to Hill and Bosque Counties and even spurred competition among several other providers.

TIF provided several success stories involving its grantees. Four are summarized here. The Joe Barnhart Bee County Library now offers public access computers, laptops, Internet connectivity, the use of Microsoft Office applications, and training to its users. Darrouzett Independent School District has been able to provide distance learning, including college courses, to its 67 students using a dedicated T-1 line and 25 computers. Before getting a TIF grant, the best the district could provide was dial-up access, at a rate of 15 cents per minute. The Texas Association of Community Health Centers Project has enabled health professionals in rural and underserved areas to receive training and professional consulting services online, thus reducing travel costs and allowing more dollars to be spent on healthcare. The project also established

a telepharmacy. With a TIF grant, Sul Ross State University is able to provide distance learning to communities such as Fort Davis, Fort Stockton, Marathon, Marfa, Terlingua, and Van Horn. Students in those communities can check out laptops to access wireless networks, online courses from the university, and the Sul Ross Network.

TLA said TexShare and the Texas Library Connection (TLC) have been successful uses of state funding. TexShare equalizes the provision of information sharing across Texas because libraries in all communities, no matter their size, have access to the same information resources as those in the largest cities. The program uses \$10 million to purchase resources that would cost the 517 public library systems and 150 higher education libraries more than \$150 million if they purchased them separately. Similarly, TLC provides public schools access to databases that they could not purchase economically on their own. For a \$400 commitment, a school library can access \$20,000 worth of information resources.

TML identified LaGrange, Ga., which has built a 60-mile fiber network and 150-mile cable broadband network for its businesses and citizens. Having recently lost a textile mill, the city leaders installed the network to attract new businesses. Marietta, Ohio, formed a nonprofit corporation to provide wireless broadband communications in rural southeastern Ohio after private companies declined to offer service. Even larger cities like Tacoma, Wash., have invested in broadband facilities to provide services to their citizens.

HOW CAN WE GET THERE FASTER?

STEPS TO ACCELERATING BROADBAND DEMAND

With such extraordinary possibilities, you would think that governments would look to remove barriers to broadband deployment and accelerate usage. And indeed, most developed nations (and many U.S. states) have plans, strategies or concerted policies to promote broadband. Yet at least one observer suggests broadband strategies will fail

when they look to governments for technology or market leadership and risk making things worse.

An important lesson taken from the Asian broadband experiences is that government policy to dictate market direction will lead nowhere. To find new markets with innovation, minimal intervention by government is required.

Certainly it is reasonable to look to new applications in a free market, more than any government defined policy solutions, to define the uptake of high-speed networks. Yet governments can take actions that help create an environment that supports innovation and demand in broadband markets. The Bush Administration has already taken multiple measures to promote aggressive broadband roll-out and usage, as have other nations around the world, and the President's Council of Advisers on Science & Technology is formulating still further recommendations for progress. Many of the recommendations have been held hostage by litigation and ambiguities associated with the 1996 Telecommunications Act, and until settled, the marketplace will continue to represent high-risk to investors.

ACTIONS BY STATE AND LOCAL GOVERNMENTS

States and localities around the U.S. are also taking steps to promote broadband demand. Some of these initiatives include:

- Consider Bandwidth when addressing issues such as rights of way,³⁵ taxes and application fees, tower siting, zoning, building and construction codes, building access, franchise agreements, historic preservation and environmental protections. The State of Arizona provides in legislation a no-fee access to public rights-of-way system to create

³⁵ For states and localities, these issues are very complex. Revenues are needed to finance police, schools, fire departments, roads, etc. Every time a street is cut up to allow new fiber deployments, its lifespan is halved. NARUC offers an extensive guide for communities to streamline local regulations to lower the costs to deploy new fiber and telecom infrastructure locally, while maintaining revenue sources for local governments. (See "Promoting Access Through Public Right-of-Way and Public Lands," NARUC, July 31, 2002).

common rules for all licensed carriers, and also establish an incentive to infrastructure buildout.

- Aggregate Demand to incent carrier deployment, as is being done in some regions such as Berkshire Connect in New England. (See “Berkshire Connect: A Case Study in Demand Aggregation,” MIT Program on Internet and Telecom Convergence, Nov. 2001). The Technology Administration of the U.S. Department of Commerce has partnered with regional organizers to promote understanding of successful demand aggregation strategies.
- Educate Citizens and Businesses. Case studies also demonstrate that improvements in telecommunications access and use have been strongly driven by effective local leadership. Ecom Ohio offered just such an example, helping Ohio businesses online increase broadband use 59% (2001-2002) while broadband adoption among U.S. businesses overall grew 27%. (eCom Ohio, “Ohio and National Business Online 2002 Survey,” 2002). A report to the Appalachian Regional Commission likewise noted: “Many information and telecommunications deficits can be addressed by improving the overall awareness of community and business leaders.” (Report, “Links to the Future: The Role of Information and Telecommunications Technology in Appalachian Economic Development, Appalachian Regional Commission, July 2002).
- Deploy eGovernment. As in LaGrange, citizens want content relevant to their lives, such as community information and local government services. For example, Franklin County (OH) auditor Joseph Testa allows citizens to renew dog licenses or access geographic information about property lines / water lines / etc. on his web site – value-adding information addressing local concerns. The North Dakota State University Extension Service in Fargo, North Dakota, uses broadband videoconferencing to train farmers at remote sites on how to manage risk in everything from production and marketing to financial and legal aspects of managing their farms.
- Remove Non-Telecom Barriers to Killer Apps. Advanced applications, such as telemedicine, could drive broadband demand and deployment

(in addition to improving health care delivery and cost efficiencies). Yet telemedicine often faces complex, non-technical barriers, such as state licensure requirements that prevent medical experts from “seeing” citizens in other states over the Internet. States looking to promote broadband (and improve health care delivery) are looking for ways to remove such barriers. Likewise, efforts to offer distance learning often face difficulty in obtaining accreditation from educational oversight bodies unfamiliar with e-learning.

- Offer Regional Broadband Planning Assistance. For example, some states like Michigan provide regional planning grants for local communities; they encourage regional initiatives to link or leverage their local strategies to the statewide initiatives, and encourage communities to identify and remove existing barriers to new telecommunications investment. The City of Flagstaff took a bold step forward in working through Greater Flagstaff Economic Council, to hire a permanent telecommunications expert to focus on Northern Arizona’s telecommunications needs. This Plan is one of the early successes of a proactive community.
- Encourage Experiments (e.g. Fiber-To-The-Home New Builds). Planned communities are springing up around the nation, with fiber-to-the-home installations increasing by more than 200% in the past 12 months. (FTTH Council, Aug. 2002). In-Stat/MDR suggests the percentage of connected greenfield homes will skyrocket from 11% in 2002 to 61% by 2006, (In-Stat, Feb. 12, 2002). These experiments and others should encourage innovation in applications and services.

ACTIONS BY BUSINESS LEADERS

Industry trade associations and business leaders are also taking steps that appear to promote broadband demand. Such efforts include, among other things:

- Promote Business and Consumer Understanding. The Positively Broadband campaign offers a good example of private sector leadership to promote awareness and understanding of the benefits of broadband. Likewise, SeniorNet is working to educate

senior citizens about what broadband can mean for them.

- Forge Partnerships Between Broadband Creators and Business Users. The Information Technology Industry Council and NFIB have announced intentions to work together to promote broadband deployment and demand. Opportunities for technology creators to work with their customers on improving awareness of applications is likely to increase demand among companies. Also valuable are surveys of business users – hearing directly from the would-be customers about why they are or are not adopting broadband, and how subscribers are using high-speed access.
- Improve Security and Protecting Privacy. These are critical to build and maintain consumer confidence, but they also represent a great opportunity. The security imperative will provide a strong catalyst for companies to re-engineer and re-think their entire operations. Successful business leaders will embrace new architectures and business processes that strengthen their place in the market and generate even greater productivity and efficiency through the use of technology. The security challenge will prove an opportunity for business. The Internet Security Alliance and Partnership for Critical Infrastructure Protection offer two good examples of industry-led efforts, although greater coordination is still needed.
- Expand Partnerships Among Educators and Researchers. The Internet2 is truly pioneering applications, services and models for online partnerships that will generate greater demand for higher-speed networks and ensure greater returns for those who use them. Northern Arizona University maintains a subsidiary link to Internet2, which is expected to grow in capability and use in the near future.
- Encourage and Supporting Telework. Organizations such as the Telework Consortium are developing pilot projects to address telecommuting issues, identify and remove barriers and pioneer best practices. Likewise, businesses seeking greater broadband deployment can lead by example and promote telecommuting among their own employees.

ACTIONS BY INNOVATORS & ENTREPRENEURS

New applications and services that consumers want and businesses need will provide the tipping point for broadband demand and usage. The developments that appear most likely to stimulate broadband demand include:

- Develop Digital Rights Management (DRM) Solutions. Finding technical solutions to copyright challenges will expand digital content willing to go online, especially entertainment, and increase the value proposition for subscribers.
- Improve Usability and Reliability of Broadband Equipment and Service. Making the broadband experience more plug-and-play – reducing deployment hassles and improving consumers' experience with service delivery – will increase demand for broadband and new broadband services.
- Develop New Delivery Platforms. Consumers and businesses may be more interested in broadband over platforms that compete with cable and wireline platforms – such as wireless, satellite, optical fiber and perhaps even power line. Such cross-platform competition would increase consumer offerings, keep prices low and encourage greater broadband adoption.
- Improve Compression and Capacity of Existing Platforms. New technologies that deliver more data, more quickly over existing copper and coaxial infrastructures, such as the new MPEG 4 standard, will give consumers the broadband experience over existing and deployed infrastructure. As the surveys show, broadband usage is “sticky,” and once consumers gain access to these applications they'll want more bandwidth.
- Develop Alternative Deployment Techniques. New ways of deploying new lines, such as sewer access robots that deploy fiber without tearing up streets and at far less cost (as in Albuquerque, NM or Omaha, NB), or last mile broadband wireless solutions, promise readier broadband availability and greater likelihood of adoption.

- Improve E-Commerce Quality of Service (Security, Authentication & Micropayments). Broadband demand will grow as we attack and solve many of the issues hindering quality of service in e-commerce – guaranteeing data rates, authenticating users quickly and securely, paying for goods and services without delay or burdensome forms, and transmitting reliable voice over IP over public networks, for example.
- Create Compelling New Content. In the end there will be no substitute for rich and varied applications that ensure returns on broadband investment, even as we spread the word about existing applications and how they can improve American business productivity and quality of life. Broadband demand will be driven by business and consumer excitement about new “killer apps” from mass-market voice over IP, to speech recognition, to 802.11 wireless networks, to unheard of new technologies under development in garages, Silicon Valley, and across the country.

SUMMARY

This chapter serves as a treatise on the issues associated with expanding broadband into rural America. It shares the views of incumbent telcos, ISPs, competitive telcos, governmental agencies, and local citizenry regarding the various ways that broadband expansion can and should be approached. What to take away from this chapter is a complete view that there are many options to consider in solving the rural access problems. And one must inherently become the top priority. In Northern Arizona, the key issue is a lack of “middle-mile” infrastructure that reaches into all the various communities. Once a path forward has been established to resolve this major gap, a more general statewide set of guidelines can be put in place to administer broadband expansion. At the moment, identifying a workable funding solution for the middle-mile is essential.



FUNDING MECHANISMS

How will progress get paid for ... ? And by Whom ?

A fundamental goal in previous chapters of this plan was to present a summary of the how broadband needs have emerged, and the sequence of events that the telecommunications industry has experienced that continue to contribute to those needs not being met in rural Arizona....or more appropriately, rural America. A recurring theme in this Plan addresses the critical components of broadband networks as two primary parts:

The Middle mile -- the very high bandwidth Internet trunks between the ISP (in a rural community, for example) and an Internet backbone provider (IBP; in Phoenix or other major metropolitan central office)

The Last mile -- the Internet connection between the end-user and their Internet service provider (ISP) – also called the local loop.

We must absolutely recognize that last-mile solutions cannot meet the needs of delivering broadband capabilities without an existing middle-mile path to transport information into and out of a community. Emphasis in this Plan is therefore placed upon identifying ways to resolve middle-mile issues as the kingpin for all other strategic plans and

actions. Communities must have access to these broadband trunks before broadband access can become a reality.

GRANT AND LOAN OPPORTUNITY OVERVIEW

The following table presents a collective summary of grant and loan opportunities. The table is referenced with web links and/or documents for further investigation by the reader so that more detailed information can be obtained regarding the amount of funding available, due dates for submission, and criteria for eligibility.

The Benton Foundation tracks many of the ongoing grant and loan opportunities and programs, and provides substantial additional information and reports regarding government, corporate, and private funding successes. The Benton Foundation web link is located at:

<http://www.digitaldividenetwork.org/content/webresources/index.cfm> .

GRANT AND LOAN OPPORTUNITIES

Grant/Loan	Funds Available	Deadline	Criteria
FEDERAL			
U.S. Dept of Agriculture - RUS Rural Utility Service	2003: \$11.3M for AZ	Annually in Jan	1. Communities of 2,500 people or less 2. Per capita income < \$14,500 3. Less than 10 people/square mile 4. Loans only....no grants http://www.usda.gov/rus/
USDA-RUS/DLT Distance Learning & Telemedicine	2002: \$200M loans; \$100M loan/grant (\$50K-\$500K per grantee min/max)	31 Aug 2003 (Annually in Aug)	- Rules vary based upon whether application is for loan or grant. http://www.usda.gov/rus/
USDA-Economic Development Administration (EDA)	Beginning FY2002, \$335M until expended.	Ongoing	1. Planning Assistance for Economic Development Districts, Indian Tribes, States, and Other Planning Organizations. (\$24M set aside; Average award \$46-68K) 2. Technical Assistance for Local, National, and University Centers. (\$9.1M set aside; Average awards \$33-108K)
U.S Department of Commerce – NTIA	\$204M in 2002; Cost-share grant projects requires matching funds	Continuous	http://www.ntia.doc.gov/top/ TOP projects are demonstrations of how digital network technologies can be used to extend and improve the delivery of valuable services and opportunities to all Americans.
U.S. Dept of Education	Total annual investment approximately \$1.9B	Various	http://www.ed.gov/offices/OVAE/grntprgm.html Grants and Programs in High School Education America's Career Resources Network Comprehensive School Reform Demonstration Program GearUp High School Reform State Grants Smaller Learning Communities Program Perkins State Basic Grants and Tech Prep Grants State Scholars Initiative Teacher Funding (ESEA) Tech-Prep Tech-Prep Demonstration Program TRIO 21st Century Learning Communities Program

			Grants and Programs in Career and Technical Education Perkins State Basic Grants and Tech Prep Grants America's Career Resources Network Appalachian Regional Education Program High School Reform State Grants National Dissemination Center for Career and Technical Education National Research Center for Career and Technical Education Native American Vocational Education Program Native Hawaiian Vocational Education Program Pacific Vocational Education Improvement Program Smaller Learning Communities Tech-Prep Tech-Prep Demonstration Program Tribally Controlled Postsecondary Vocational and Technical Institutions Program Grants and Programs in Adult Education and Literacy State Grants Adult Literacy Research Network Community Technology Centers Correctional Education: Lifeskills for State and Local Prisoners Program Correctional Education: Incarcerated Youth Offenders Program Empowerment Zones/Enterprise Communities English Language/Civics Instruction TECH21
U.S. Department of Health & Human Services	Various – Refer to the following links: http://www.hrsa.gov/budget.htm and http://www.hrsa.gov/budget.htm		http://www.hrsa.gov/grants.htm
PRIVATE and CORPORATE			

HP-Digital Village	\$15M (periodic) (3 recipients)	Varies	http://www.ntia.doc.gov/top/publicationmedia/news/1tr/T_news1.htm#Digital_Village
3-Com	e-Rate: Application Assistance only Urban Challenge: Up to \$1M total; \$9K local assistance	Varies	http://www.3com.com/solutions/en_US/government/programs/urbanchallenge_ameriacorps.html Urban Challenge is a “Cost Share” grant program
Gates Foundation	Approximately \$1.2B in 2002	Varies by subject	http://www.gatesfoundation.org/ Grants cover areas of: Global Health, Education, Libraries, and Special Projects.
AOL/Time Warner Foundation	Amounts vary; typically \$1M to \$5M per year.	Varies	AOLTWF supports programs that use the Internet to improve the lives of families, children and the disadvantaged.
AT&T Foundation	Not published	Varies	This Foundation invests in education, civic and community service, and the arts in communities where AT&T has a significant business presence.
Cisco Foundation	Not Published	Varies	This Foundation provides funds for community projects in San Jose, California, with a focus on education, workforce development and basic human needs.
IBM Philanthropy Grants and Fund for Community Service:	Not Published	Varies	This majority of these grants focus on K-12 education initiatives with some smaller grants for economic workforce development and arts and culture.
Intel Education	Not Published	Varies	The Intel Foundation provides grants to support science, math and technical education, improve the effective utilization of technology in classroom teaching, and increase the number of people, especially women and minorities, pursuing technical careers.
Microsoft Giving:	\$247M in 2002, TBD in 2003	Varies	Microsoft Giving is focused on creating greater access to information technology in disadvantaged communities worldwide. This is accomplished through the support of higher education, youth programs, nonprofit technology solutions, public libraries and the creative community.

Annie E. Casey Foundation	Varies by subject	Varies	The Casey Foundation makes grants, funds demonstrations, provides services and disseminates data and analyses aimed at helping states, cities, and neighborhoods support children and families.
Kellogg Foundation's Managing Information with Rural America	Varies by subject	Varies	A grant to help people in rural communities determine how technology can be used to address economic development, education, health and leadership.
National Cristina Foundation	Makes available recycled computers and software	Continuous	This group provides computer technology and training for people with disabilities, students at risk and economically disadvantaged persons.
Robert Wood Johnson Foundation	Awards vary; few telecom related applications	Various	This group works to improve care and support for people with chronic health conditions and ensure that all Americans have access to basic health care at reasonable cost.
STATE			
Arizona Department of Commerce – Community Telecommunications Assessment (CTA)	Estimate: \$500K annual in grants ; based upon legislative approval.	Varies: As Announced	http://www.commerce.state.az.us/Rural/default.html
Greater Arizona Development Authority - GADA	Up to \$250K loan	Continuous	http://www.gada.info/ Loans for Technical Assistance and Project Consulting Services.
Arizona Foundation	\$18.3M in 2001 in loan support	Varies	https://www.azfoundation.org/rfp/index.xpl The AZ Foundation is a philanthropic organization with a focus on health and welfare.

The grant and loan opportunities listed in the above table are very specific about their intended purpose. The criteria set forth by the grant or loan administrator dictates what may or may not be funded as a proposed project. There are many opportunities for grants and or loans that support projects related to philanthropic interests (community education and health activity support).

Of the above listed grant and/or loan opportunities listed above, only the USDA's Distance Learning and Telemedicine (DLT), Economic Development Administration (EDA), and NTIA grants, and a modest few of the Department of Education grants offer funds that might be used to acquire and broadband infrastructure. And the limited funding made available would severely limit creation of

middle-mile broadband resources. Since those are needed before any further broadband capability may be built, these grants and loan opportunities should be pursued only after a middle-mile solution has been identified and moving toward approval.

OTHER SUPPORTIVE ORGANIZATIONS

RURAL BROADBAND COALITION



In addition to many of the services of grant and loan offering agencies listed above, the Rural Broadband Coalition (RBC) was formed recently to assist communities in developing strategies and plans for acquiring access to broadband. The Federal government announced its support for \$1.4B through the U.S. Department of Agriculture to help jump-start rural Internet Service Providers. Currently, the program is projected to put these funds to use over the next six years.

The Rural Broadband Coalition (RBC) was recently founded by a group of consultants to help ISPs and others take advantage of the money that's pouring in to the broadband program of the [Rural Utility Service](#) (RUS), a service of the US Department of Agriculture (USDA) as outlined in the table above.. Details of the RBC organization can be found at: <http://www.ruralbroadbandcoalition.net/>.

The RUS successfully brought electricity to many rural communities implementing the Rural Electrification Administration Act of 1936. Now the service has a similar program to bring broadband Internet to rural communities. The service defines rural communities as having a population of 20,000 or fewer.

Mission: The Rural Broadband Coalition (RBC) is a national association of government organizations, telecommunication companies/utilities, for-profit utilities, rural electric cooperatives, municipalities, public utility districts, technology companies and associations, Internet service providers, and other interested parties that are dedicated to supporting

the deployment of broadband Internet access to rural America.

Overview: Rural America, which is home to nearly a quarter of the nation's population, comprises 75 percent of this nation's landmass.

Competition and active participation in today's vigorous new economy requires not only a computer, but also high-speed, high capacity (Broadband) access to information and data on the Internet. While the Internet is changing the world economy, technology experts say, "large parts of rural America are losing out on jobs, economic development and civic participation" because of inadequate access to the Internet. Traversing vast expanses of remote and often rugged topography presents unique financial and technological barriers.

This "broadband divide" - the gap between the technological haves and the have-nots - is widening. The U.S. Department of Commerce confirms the gap has increased, in four digital divide surveys conducted in 1995, 1998, 2000 and 2001. The 2001 survey finds that while recent dial-up access has increased in rural areas, broadband availability still lags far behind urban areas. Commerce Department surveys consistently find that regardless of income level, rural Americans are less likely to have high-speed home Internet access.

RBC believes that broadband will soon be considered as essential as "traditional" utility services. Recognizing this, RBC see a parallel with rural electrification programs of the 1930's, governmental organizations and industry have a significant role to play in bridging the "digital divide" by bringing broadband to rural and underserved areas. To help accomplish this goal, the USDA's Rural Utilities Service (RUS) announced a \$2 billion dollar grant and loan program to help fund the deployment of rural broadband.

RBC and its members hope to become the leading representative and proponent of universal broadband Internet access for rural communities.

RBC intends to accomplish the following goals:

- Promote open access, competition, and innovation at the federal/state level for rural broadband Internet access;
- Encourage both public/private investment and partnerships in developing rural broadband Internet access;
- Develop value-added communication channels to provide member value with timely updates and publications relevant to the industry; and
- Establish forums for discussion of rural broadband Internet access through conferences and other events suited toward facilitating knowledge dissemination.

It must be kept in mind that activities supported by the RBC are funded – at least in part – by membership subscription. And principal activity is guided by the USDA and its policies for grant or loan submissions as prescribed. Therefore, the RBC should not be considered a direct funding source or a decision making element for USDA grant submissions they affiliate their support activity to.

The RBC is likely to expand its role in helping rural communities identify funding sources other than just the current USDA vehicle. If that occurs, other funding might be made available from grantors with different eligibility criteria.

SUMMARY

What the reader should take away from this chapter is a list of resources that may be used to pursue grant or loan opportunities that can enhance - to a limited extent – their community's ability to make internet service available. If middle-mile resources do exist in your community, and broadband access is available, the funding opportunities listed above can make a significant difference in the areas each grant or loan opportunity offers.... i.e., education, telemedicine, distance learning, libraries, and many other special project areas.

If the middle-mile trunks capable of supporting broadband *do not* exist they must be pursued with the highest precedence so that local broadband access may be enabled once they become available. In the interim, using one or more of the grant and loan opportunities listed above may provide

reasonable dial-up solutions that may be easily upgraded to broadband connections once the middle-mile trunks and local broadband access become available.

Middle-mile resources being funded is the hardest problems because of the expense they represent. GFEC, in conjunction with organizations like the Northern Arizona Council of Governments (NACOG) and the Alliance for the 21st Century, has already begun to address this issue by developing proposed strategic funding solutions that would enable deployment of new middle-mile infrastructure to rural Northern Arizonans in the quickest possible timeframe. A very short summary of how this funding model might be established is provided in Chapter 8, the most prominent being creation of a Broadband Service Fund and designated agency to administer the program.

RECOMMENDED ACTIONS

Policies and Actions ...

Many options exist to address how communities can make headway toward obtaining the telecommunications services they will undoubtedly want and need. Most of these options and considerations were addressed in Chapters 5 and 6. Changes in Arizona's telecom landscape that have happened in the last few years - and even months - provide significant insight into what actions by communities are possible, and what actions are recommended to address Northern Arizona's needs.

We must first recognize that the single largest issue facing rural Arizona (rural America, actually) is based on how the telecom industry has evolved, and that if we collectively believe that the major service providers in our region will be responsive to our needs for broadband, we are likely to be disappointed. A review of the last 20 years reveals why this is true.

AFFORDABLE BROADBAND WON'T MAGICALLY APPEAR

It was 1984 when the AT&T monopoly was broken up into the initial seven Baby Bells companies. At that time, AT&T enjoyed its reign, having control of approximately 85% of the phone lines in America... and the monthly revenues associated with them. AT&T's annual profits were between \$5-6 billion.

After the break up things happened that were in no way expected, however. The vision of instilling a "competitive" marketplace was squelched as the Bells adapted to their new environment. What

started out as a cooperative effort to ensure that systems were interoperable, that costs were reasonable equal, and that territorial boundaries were defined, turned into a much tighter interrelationship - under the guise of an industry association known today as the National Telecommunications Industry Association (NTIA). Through this association, the Bells companies have reconstituted themselves into the equivalent of the original AT&T, and have exercised their cooperative efforts as a "natural" monopoly - one with enough clout to sustain a phenomenal power base against competition and regulation.

The Bells, operating as what has been termed a "cartel,"³⁶ have successfully been able to ward off competition for the last 18 years despite private investment and legislative efforts like the 1996 Telecom Act to establish competitive service alternatives to Americans. Over \$600 billion was spent at the onset and shortly after passage of the 1996 Act by over 700 new start-up firms looking to break into the competitive marketplace. The investments created over 250,000 jobs as well. But the power of the Bell companies is overwhelming - even to the organization chartered to oversee them - the FCC - whose \$480M a year budget severely limits the extent of their assigned oversight responsibilities.

If regulatory oversight could have been successful in controlling the Bell companies, we would expect

³⁶ Reference a report entitled "[Broken Trust](#)," by Daniel Berninger, Managing Director, Pulver.com.

to see increases in our phone bills that are at most, commensurate with inflation. That would translate our 1984 telephone bill from an average monthly cost of \$6.50, to \$7.60 today. However, through the use of obscure service “packages,” the addition of misunderstood fees, an average phone bill today (less any long distance charges) is typically between \$30 and \$40 in Arizona. But prices were supposed to go down after the monopoly break up, weren’t they? And service get better?

The Bell companies support 60% more phone lines in 2002 than in 1984, but they do so with roughly the same staff size as 1984. They enjoy approximately \$150B in revenue operations. The annualized profits since 1984 of the Bell companies have escalated from \$6B to nearly \$22B, more than 3 times the corresponding inflation rate. Protecting those profits provides enormous incentive to spend some of them managing regulators, and annual expenditures for lobbying and litigation - the *reported* ones - exceed \$1B annually. The Bell companies have a direct staff of over 300 people working on Federal issues, as well as hundreds of hired lawyers, lobbyists, consultants and academics. The FCC is certainly at a disadvantage.

While this is all good information to formulate an idea of how the telecom landscape shapes up, we should focus more locally - in particular, on Qwest - to gain an appreciation of what Northern Arizona’s should expect.

EXPECTATIONS OF QWEST

For most Northern Arizona’s, the principal supplier for telecom services is Qwest..... they are the recognized ILEC. And they have had financial difficulties that will affect every aspect of consumer services they offer. Having been strapped with an estimated \$26B in accounting anomalies in the last year, Qwest is in the midst of restructuring itself to reestablish a healthy market position. The recent sale of the QwestDex service for \$7B, and renegotiation of long term loans should restore a reasonable financial foundation, but the nearly \$20B debt will continue to affect Qwest’s ability to invest. This is a key factor for the near-term for Arizona’s....particularly the rural ones, since they are the ones who need most the costly investment of

fiber resources to use as a starting point for broadband expansion.

If Qwest is not in a financial position, or is for other reasons resistant to make the infrastructure investments needed, how can rural Arizona ever get over its “Digital Divide?” This has long been the subject of attention by the Governor of Arizona, and the three principal organizations who are chartered to directly address this issue:

The Arizona Corporation Commission (ACC) - Utilities Division

The Arizona Department of Commerce (ADOC)

The Government Information Technology Agency (GITA)

But What About the Federal Government - What Can They Do?

Before delving too deeply into how the State organizations are best positioned to address the problems rural Arizonans face, it is worthwhile noting how the Federal Government is dealing with (avoiding, actually) the problem.

The 1996 Telecom Act - while a hallmark legislative effort to establish a competitive landscape for telecom - was fraught with legal ambiguities that opened the door for challenges by the incumbent Bells. Issue after issue, case after case, have been brought to address the legislative mandate to “open up the lines” for competition. Both passive and active resistance by the Bells took its toll on the lion’s share of new start-ups hoping to capitalize on what was perceived as a great business opportunity. The start-ups are mostly gone now - along with billions of dollars in capital investments, the jobs, and the hopes that anyone can ever successfully penetrate a market so tightly controlled by such a powerful group as the RBOCs.

The FCC had until recently even indicated its notion of abandoning the “competitive” aspects of the 1996 Act and reducing, if not eliminating, a significant amount of regulatory control over the Bells.³⁷ The

³⁷ In this article entitled “[FCC Preparing to Overhaul Telecom, Media Rules](#),” Frank Ahrens of the Washington Post provides an overview of why FCC regulators must consider as one of their options the possibility of favoring Bell company arguments about competitive access to lines, and how it continues to drag down the telecom industry if the 1996 Act is not changes in their favor.

1996 Act did provide an avenue to convey much of the regulatory power to states, shedding the legal burden in the process. Though vague regarding how, and the FCC has just recently delineated additional guidance in its August 21st Ruling ([FCC 03-36](#)).

In this Ruling, the FCC added what many ILECs view as an onerous twist: a role for states to play in determining who has to share what and where. Under the new rules, the commission will maintain a list of major resources all ILECs will have to make available to competitors while states will consider a subset of elements that are based on local market needs. Although the FCC says the approach offers the certain stability necessary to enable parties to make investment decisions, it could create a patchwork quilt of regulations that stymies industry advances and leads to protracted legal action. Time will tell.

While the FCC ruling is well reasoned, it is trying to address a wicked problem where potential solutions can cause more trouble than they solve. And in order to mitigate or eliminate the legal entanglements expected to ensue, it might just be easier to get out of the way and let the market decide. ILECs had promised to accelerate deployments of broadband in exchange for elimination of the 1996 Act's Section 251 requirements. This did not happen. So for now, the Section 251 confrontation is not fully settled, and the only things clear regarding changes in the telecom landscape are that new approaches by potential competitors will take time to develop....and that more litigation will be spawned in the process³⁸.

As a noteworthy event which could influence future FCC regulatory issues, the Chair of the U.S. Commerce Committee which oversees the FCC recently transitioned to Senator John McCain of Arizona. He has a history of favoring deregulation, and recently was quoted saying "the agency would

make 'monumental decisions' this year that 'will shape the future of communications forever.'"³⁹

Nevertheless, Qwest's current debt ratio is not conducive to accelerating rural broadband infrastructure. Recent press indicates that Qwest's metropolitan areas will be the focus of most of their capital investments rather than rural areas.

Back to the State . . .

That said, we must look at how this translates to Arizonans. Qwest is the "cash-poorest" of the Bells, so the likelihood of significant and rapid movement into rural Arizona with infrastructure capable of supporting broadband - on a wide scale - is *s-m-a-l-l*. If the cost to deploy infrastructure is high, the resultant cost of service offerings will be high as well - not just for businesses, but residential broadband also.

With the change of leadership (i.e., Governor et. al.), telecommunications has again raised to the forefront of issues facing rural Arizona. ACC, ADOC and GITA are actively involved in evaluating a variety of ways the state can address the issue. The [Arizona Telecommunications and Information Council \(ATIC\)](#) is a principal resource to State Agencies by performing as a "*recognized and authoritative apolitical source of information and expertise on telecommunications and information technology infrastructure for enhanced economic development and quality of life in the New Economy.*"⁴⁰

ATIC has been actively involved in the formulation of the principal goals, along with a definitive set of recommended actions which should be taken in formulating State policies and programs. The summary of recommended actions previously addressed in [Chapter 2](#), and are provided in summary form here:

³⁸ Telephony Online in ([CLEC appeal strategy is to avoid D.C. Circuit.htm](#)) announced on September 11th, AT&T and at least eight other CLECS files suit against the provisions of the FCC August 21st Ruling, ensuring that a long-term legal battle is certain.

³⁹ Article entitled "[FCC Chief Dismisses Talk of Extensive Rule Changes](#)," by Elizabeth Olson, New York Times.

⁴⁰ The Arizona Telecommunications and Information Council (ATIC) is an economic development foundation under the [Governor's Strategic Partnership For Economic Development \(GSPED\)](#).

- An **income tax credit** for businesses or individuals that deploy broadband services to rural and under-served communities.
- An **income tax credit** for businesses that deploy inter-city/town transport services to rural and under-served communities.
- An **expedited right-of-way permitting process** for establishment of inter-city/town transport.
- **Use of existing financing mechanisms** as vehicles to aid in deployment of broadband services and inter-city/town transport in rural and under-served communities.
- Expansion of the existing Arizona Universal Service Fund to finance deployment of advanced (broadband) services.
- Continued and expanded funding of the Arizona Department of Commerce's Community Telecommunications Assessment program.
- Establishment of a statewide strategic plan for broadband deployment.
- **Investigate use of State-owned facilities**, such as microwave towers and rooftops, to enable private sector broadband deployment to communities.
- Investigate use of new Federal homeland security dollars to enable establishment of redundant public networks.
- Encourage establishment of public/private partnerships to enable broadband deployment.
- Continued support of GITA's TOPAZ program.
- **Prioritize** actions across the state based on documented need.

Collectively, these actions will help support the State's push for rural broadband. But none of these efforts will install infrastructure by itself - or directly fund efforts to do so. Historically, that has always been left up to service providers (incumbent or competitive) like Qwest or AT&T. Most communities in Northern Arizona have neither **middle-mile** or **last-mile** infrastructure that can deliver broadband capabilities on a broad and affordable scale to all citizens. Some communities like Flagstaff are more fortunate than others by having access to middle-mile fiber resources, and multiple wired and wireless service providers. But even those are beginning to stretch capacity limits, and no redundant path exists that will accommodate any loss of the single cable between Flagstaff and

Phoenix. Any outage between these two cities affects virtually all of Northern Arizona, since the Flagstaff CO is the hub for virtually all telephony and data traffic to cities and towns within a ~100 mile radius.

At the current time, no scalable high-speed circuit resources (fiber) exists to cities like Page, Grand Canyon, Tuba City, Winslow, the Hopi or Navajo reservations and virtually all towns small in size. Limited microwave circuits have been implemented to some towns, but the basic high-speed infrastructure to support a robust broadband service delivery simply does not exist. Nor are there plans in place by Qwest to resolve the infrastructure inadequacies with their financial situation unresolved.

OPTIONS AND APPROACHES

So what are Northern Arizona's options? And of those, which is the best, and why?

Let us first make a list of the most promising, since many of these have been or are being employed today.⁴¹ These are summarized in the following table. And following sections address a few of the pro's and con's of each.

⁴¹ Other strategies and options are also being considered, and there are likely more to emerge over time.

OPTIONS & APPROACHES

OPTION	WHO BEARS INITIAL COST	NOTES
Municipal Utility Network ⁴²	The City or a designated municipal utility for the community. Bonds or local funding provides investment.	State law must permit it (AZ does not forbid, but few cities have funding needed to begin such projects)
Public-Private Partnerships	Shared cost between public and private entities; terms “negotiable”	Identifying viable partners is very difficult because of large investment.
Tax Incentives	Private investment enticement	May be adequate reason for cash “rich” providers but takes revenues away from the State...possibly for extended periods.
Service Fund for Broadband	Like Universal Service Fund (USF): Subscriber pays small monthly fee. Administered in AZ by the AZ Corporation Commission (ACC)	Very small fee, but can accumulate large infrastructure fund for application to infrastructure builds.
Establish Broadband Development Agency	State-level organization chartered to establish policy, plans, and administer funding through legislation.	Requires expansion of government agencies, and funding (taxes).
Service Provider Direct Investment in Build Out	The ILEC, CLEC, Cable Co., ISP, or Overbuilder bears the investment costs.	Very large capital investment; business model ROI must be met.
State Provided Funding	State generates funding through legislation and [likely] tax increases; infrastructure is contracted through a State organization like ADOC or GADA.	With budget deficits on the order of \$1.4B over the next 2 years, it is not likely to be legislatively supported.
Federal Funding and/or Assistance	Federal government funds through grants (typically). The largest is through USDA, but others exist. There is substantial support growing in Washington to establish other avenues of funding, but these have not yet been defined. Possibly in coming years.	Grants are generally small relative to the infrastructure investment needed, and funds are generally not for use in establishing “middle-mile” resources.

⁴² See the article available from MSNBC, entitled “[Public broadband catching on](#),” 27 January 2003; also available in softcopy as a hyperlinked document - “[Click Here](#)”

Let's look at these in a little more depth.

Municipal Utility Networks

Municipal utility networks have made great strides in the last year or so. Cities and towns all over the U.S. have adopted the concept. Example cities like Palo Alto, CA, Glasgow, KY, Munising, MI, and even Chicago, IL, have begun to take control of their broadband destiny. The benefits of Public Broadband Systems include:

- Access to advanced communications services vital to economic growth, educational opportunity, affordable health care and quality of life
- Advanced communications services are not likely to become available soon at affordable prices in many communities outside dense population centers *See, e.g.,* J. Baller & S. Stokes, "The Case for Municipal Broadband Networks: Stronger Than Ever" (Fall 2001), available at <http://www.baller.com/library-articles.html>

By owning its own communications network, a community can maximize its ability to:

- Control the types, quality, reliability, timing and location of communications services deployed in the community
- Ensure that services will be available to the community at the lowest possible price
- Promote universal access and interconnectivity
- Enhance the community's economic development, educational opportunity and quality of life
- Minimize disruption to public property and maximize efficient use of public rights of way
- Improve government efficiency and communication with the public
- Enhance the local government's revenues from, and decrease its external expenditures for, communications services
- Spur incumbent providers to lower prices and improve quality of service
- Amounts saved will remain in the community, where they will typically recycle four or more times

A credible threat of municipal entry may be sufficient to cause significant changes in an incumbent's performance.

Communities that operate their own electric utilities are particularly well-suited to operate their own communications systems (infrequent in AZ).

There is a substantial amount of background material regarding communities that are operating or pursuing metropolitan networks as a path to their broadband service future. Over 500 communities are providing telecom service to local government, schools, and residents through their public utilities. As a result, private companies - particularly ILECs - are crying foul since they cannot come close to meeting the service prices.

Despite the obvious attraction to municipal broadband solutions, there can be significant issues with pursuing it. First and foremost, the concept of municipal networks is forbidden in 11 states (not AZ though). And the FCC is dealing with a major court battle regarding the definition of competitive "entity" as prescribed in the 1996 Telecom Act - the outcome of which could go so far as to shut down some existing municipal networks if not seriously affect their operation as a result of court findings.

The other principal issue facing communities entertaining the thoughts of implementing a municipal network is cost. Few cities or towns have the funding immediately available to begin laying infrastructure adequate to support the entire community. The cost to do so is high, very high. And few cities or towns are willing to succumb to the increased tax burden to get things started. In Arizona, it is possible to put forth such a proposition either at the State, Regional, or Local level. Avenues to establish a State bonding agent (probably the Greater Arizona Development Authority - GADA) are being pursued by GFEC, and supported by the Arizona Technology and Information Council (ATIC).

Summary: Municipal Networks represent the most proactive way a community can approach affordable telecommunications - particularly *broadband*. Before pursuing this as a solution though, the pending outcome of the FCC, and possibly Supreme Court, disputes by the Baby Bells must be settled.

Once that happens and the details are understood, the funding source(s) must be defined. There are two parts of the architecture that must be funded and completed:

- The *middle-mile* has to exist before the local infrastructure has a path to deliver broadband. If these trunks (typically fiber or fixed wireless) do not exist, they can easily cast bills in the millions of dollars - a cost most community residents are not be willing to bear.
- The *last-mile* is just as essential as the middle-mile. And it is the “local” network piece intended to reach the entire community. It is the piece municipalities *may* be willing to fund. There are various technologies to satisfy this piece of the network. Each has advantages and disadvantages. And GFEC is willing and able to assist communities with tradeoff analyses, design and cost considerations. Keep in mind, though, if middle-mile exists to a community, there is likely to be many service providers willing to implement last-mile solutions like DSL, cable modems or wireless delivery of broadband. But probably at higher cost than the municipal network could offer.

Public-Private Partnerships

A Public-Private Partnership can mean many things, but the goal of these partnerships involves a willingness of multiple parties to share the cost of improving services to a designated area. Examples of this concept include:

- Local government partnering with a service provider to share the cost of laying fiber throughout a city to enable a broadband service foundation.
- Businesses establishing a partnership to share the cost of acquiring high-speed access to a common business park location (e.g., a developing business park)
- Businesses and government entering an agreement to share common infrastructure improvement costs in support of reducing the long term cost of internet access for both.

Some communities throughout the U.S. have engaged in this model to address significant telecommunications shortfalls. It does, however,

involve up-front funding by the engaged partners. Typically, though, this model is not used to address inter-city (middle-mile) infrastructure installations because the cost is so high. There have been exceptions to this where fixed wireless is able to resolve the bandwidth issue at reasonable cost though.

For rural cities in Arizona, the major issue is the non-existent “middle-mile.” Since the cost of these resources is high, it is not possible for most communities to entertain the option of local partnering as a means of resolving the broadband access issue. In these instances, attention must be focused toward a solution that provides access to large capital dollars to resolve middle-mile inadequacies first. Once the broadband trunk is available to a community, partnerships can be an effective and expedient way to approach the local infrastructure issue. It is essential for a community to have an engineering assessment conducted that is structured against a detailed set of requirements in order to identify which options best satisfy the community’s needs. The assessment should also be able to provide cost estimates of the various solutions. Once this information is available, partnerships may begin the negotiation and planning processes.

Partnerships are not easy to manage. Each partner is likely to be quite cautious - both fiscally, and legally - to ensure that they get “what they paid for.” Expect, therefore, the funding and legal aspects of this process to add significantly to the perceived schedule. It is not unreasonable to assume that the preparation process leading up to the actual construction could take two to three (or more) years. However, in instances where the community is small and cohesive, this time may be significantly shortened.

Tax Incentives

Tax incentives are a relatively straight forward way to entice service providers (e.g., ILECs, CLECs, ISPs and/or Cable companies) to invest capital in infrastructure expansion. The terms of the incentive can be structured in single or multi year form. The tax incentive mechanism can be legislatively effected at the Federal, or State level. The Federal incentives most often occur as part of an “economic stimulus” package, offering increased deductions for

capital investments. For large telecom providers like Qwest, Citizens, or CenturyTel, these incentives may translate to millions of dollars of additional capital being made available to lay additional infrastructure. Typically, though, tax incentives packages have not applied rules regarding *where* investments occur (i.e., rural versus metropolitan areas).

Tax incentives at the State level may be similar to those at the Federal the state level, offering capital investment incentives as well. At the State level, these incentives are often substantially less than Federal ones, since corporate tax percentages at the State level are substantially less than Federal.

Metropolitan areas are already rich in fiber and other broadband resources. Therefore, it is essential to structure any tax incentive package in a way that focuses most if not all of the incentive toward “rural investment” credits.

In Arizona, ILECs like Qwest’s or Citizens’ capital budgets are already so severely constrained by long-term debt and reduced revenues, that tax incentives may not free up enough capital funding to make any significant improvement to rural Arizona infrastructure in the foreseeable future.

Service Fund for Broadband

Arizona, like many other states, established a Universal Service Fund (USF) as a funding mechanism to ensure that infrastructure capable of providing basic telephony (life-line) is available to its citizens. The rules regarding the USF are legislated by Congress, and administered Federally through the FCC.⁴³ A complete summary of the purpose and administration of the USF by the FCC can be viewed at <http://www.fcc.gov/oig/oigaudpm-usf.html>.

The Arizona Corporation Commission (ACC) administers the USF for the state of Arizona. Additional information regarding Arizona’s USF can be obtained at:

<http://www.cc.state.az.us/utility/telecom/ausf-faqs.htm>.

⁴³ The Federal Communications Commission’s continuance of the USF, and a summary of the rules and conditions are contained in “[FCC USF Continuance.doc](#)”, also available at <http://www.fcc.gov/oig/oigaudpm-usf.html>.

As currently structured, the USF would not permit direct use as a vehicle for funding *broadband* infrastructure. The FCC directive continues to identify infrastructure to support essential telephony service as traditional copper infrastructure. This interpretation is receiving more and more attention by major providers and the FCC as time passes, since the cost of fiber in some cases is dropping below the far less capable copper lines.

Some states have implemented “infrastructure fund” organizations, the most progressive being Texas. The Telecommunications Infrastructure Fund (TIF) Board⁴⁴ serves as the enabling organization for funding statewide broadband access specifically to support required state broadband access objectives (i.e., schools, government, health, economic development, etc.). The TIF administers a large budget - nearly \$200M in 2002. It administers the funds through grants, loans and awards.

The concept of implementing an “Arizona Broadband Infrastructure Fund - (ABIF)” similar to the USF is viewed as one of the most proactive and expedient ways to address the “middle-mile” issue. With Arizona’s budget deficit, and an interest in not increasing tax burdens, legislative efforts to obtain State funds for infrastructure expansion will not be well accepted by the public - since the required investment could possibly add over \$250M in tax burden to put middle-mile fiber to virtually all of rural Arizona. This could be spread over a few years, but the bill would be high nonetheless.

One method implementing a workable and affordable ABIF would be to use the existing telecommunications framework using the USF as a model. A brief description of how this fund would work look something like this:

THE “ARIZONA BROADBAND INFRASTRUCTURE FUND (ABIF)” CONCEPT

Current residential telephony services within Arizona already implement a \$0.01 (approximately)

⁴⁴ Details of the charter of the TIF Board and the strategy may be reviewed in the “[Texas TIF Strategic Plan](#)”, or from their web site at <http://www.tifb.state.tx.us/>

per line charge attributable to the Arizona USF.⁴⁵ In 2002, the total collected funding made available from the National Exchange Carriers Association, administrator of the fund, was approximately \$900K. This funding amount is not large, and dedicated to “buying down” the cost of telephony infrastructure in remote areas. However, if the line charge were raised to, let us say, \$0.50 per line per month, the amount of accumulated funding would be 50 times greater - around \$45M per year. This amount of funding would provide a substantial budget that could support major infrastructure installation throughout rural Arizona.

This concept does not necessarily propose that accommodation be made to incorporate these increases nor change the charter of the USF as it is defined today, but rather implemented as a supplementary service fund.

Preliminary estimates indicate that over 90% of the rural Arizona communities between 5,000 and 25,000 not currently served by broadband capable trunks, could be equipped with fiber within the first two years of implementing the AIBF. In addition, primary trunks that would provide redundancy to communities already served by fiber could also be enabled with AIBF funding in those first 2 years.... at a cost of 50 cents per telephony subscriber line. The AIBF concept has been presented at the staff level of GITA with warm receptions. Much work has yet to be done to assemble the complete plan in preparation for discussion with the ACC, who would likely become the administrator of the program and funding.

Advantages of this plan are as follows:

- Infrastructure becomes a “state-owned” resource that providers can attach to. Since they did not have to make huge capital investment, it should significantly reduce the service implementation costs, and ultimately the cost of service to rural communities.
- State Government would have the option to implement it’s own network or network segments at significantly reduced cost as a

means of improving government, education, rural economic development, healthcare, and whole host of other functions on very high speed trunks. These networks could be private if need be to support law enforcement, homeland security, and migration to IP voice and video migration to significantly reduce intrastate telephony costs.

- Maintenance of state-owned infrastructure could be accommodated under ABIF funding without requiring establishment of infrastructure repair crews. Insurance costs could become an inherent annual cost by leveraging and contracting through existing provider repair crews.
- Once middle-mile infrastructure is in place, AIBF funds could be applied towards last-mile broadband issues in rural Arizona communities, especially ones where broadband service providers are not stepping up to meet their communities broadband demands.

Establish a Broadband Development Agency

The most well developed model developed to date is in Michigan. Details of the Michigan Broadband Development Authority (MBDA) can be found at: http://www.michigan.gov/treasury/0,1607,7-121-1750_19156---,00.html.

The MBDA is an independent agency created through legislation, and capitalized by the State housing Authority through a \$50M investment in 2002. Their mission is to provide low cost financing to expand more affordable high-speed internet service throughout the state. Participants in the Board include the State Treasurer, Director of the Housing Authority, and the head of the Michigan Economic Development Authority, as well as six Governor-appointed members.

The MBDA is empowered to issue investment grade, taxable and tax exempt bonds to finance and facilitate construction, operation and maintenance of broadband infrastructure. Bonds may be repaid from earnings on the operation of broadband projects. A reserve capital account secures notes and bonds of the Authority and may establish a capital reserve fund for payment of principal and interest of notes and bonds. The MBDA can offer seed capital loans, and may enter into joint venture or partnership agreements with broadband

⁴⁵ There are actually a variety of USF rates applied depending on the “type” of line. Intrastate toll line USF rates are tariffed at approximately \$0.15 per line.

developers and operators so long as tax-exempt bonds are not used to finance residential, business or other commercial customers. A complete overview of the MBDA is available in "[MBDA Brochure](#)."

Summary: The MBDA was initiated from recommendations of a consulting firm supporting the Michigan Governor. The process of formulating creating the charter and the legislation took approximately nine months. The legislation is a fairly flexible document consisting of only 5-6 pages that can be obtained from MBDA representatives if requested.

MBDA maintains a permanent staff of ten people. They currently function as an underwriting agent for loans and bonds leveraging the \$50M Housing Authority investment as the funding vehicle. Original legislation proposed creation of "Broadband Service Fund," that would tariff telephony lines at a rate of \$0.01-0.02 per line per month, yielding a more permanent source of continuing funding for the MBDA. This proposal was written out of the final legislation.

Arizona is uniquely different from Michigan, since the availability of fiber is relatively diverse, and access to middle-mile resources is generally not the principal issue to enable broadband services into rural areas. The larger percentage of MBDA clients will engage on the basis of establishing last-mile service. While an agency like the MI Housing Authority may exist in Arizona with a willingness to invest in the creation of an "MBDA-like" agency, providers in Arizona would probably shrug off the low-cost loans because of the lack of middle-mile. Even with the low-cost loans, creating the middle-mile would be prohibitively expensive, and not meet their business model ROI goals.

Service Provider Direct Investment and Build Out

It is not likely with the current financial situation that any significant investment in rural Arizona will be made to support expansion of broadband by service providers. Qwest, as the primary ILEC by service providers. Qwest, as the primary ILEC is strapped by nearly \$17B of long-term debt. Other providers like Citizens or CenturyTel are also carefully trying to manage their budgets which, for the near term, severely limit the amount of capital available to expand costly, middle-mile infrastructure.

Even having access to low-interest loans, business models generally do not indicate significant near-term ROI that incent providers to pursue them. Competitive providers, funded originally through venture funding when the 1996 Telecom Act was passed, have failed to be successful, and funding for any new ones is virtually unavailable in the current market situation.

Arizonans should not expect ILECs, CLECs, Cable Companies, or any other independent provider to establish major middle-mile infrastructure investments in the near future. In fact, it may be years before that happens for some providers. Other options must be pursued by Arizona communities if broadband is to become realizable within 2 years. Especially if it entails middle-mile infrastructure installation before a service provider can open up shop there.

State Provided Funding

With the current budget deficit being estimated at \$400M for this fiscal year, and possibly \$1B for next fiscal year unless adjustments are made, it is not likely that any significant funding might be made available through appropriation without momentous resistance. And what is needed most is middle-mile infrastructure which is the most costly part of doing broadband expansion. Communities should not, therefore, look forward to the State as a direct funding source in resolving broadband access issues. Coincidentally, it neither desirable nor appropriate practice for States to lay, own and operate and maintain statewide infrastructure.

Federal Funding

The Federal government under the current Bush administration has made clear its support for the expansion of broadband in recent U.S. Department of Commerce's Office of Technology Policy (OTP).⁴⁶ Federal funding is administered from the government department offices, e.g., Departments of Commerce, Agriculture, and Education, as the three principal grant administrators as discussed in this plan's "[Grant Opportunity Overview](#)."

⁴⁶ Reference OTP document "[Understanding Broadband Demand](#)," U.S. Dept. of Commerce, 23 September 2002.

SUMMARY

With access to broadband trunks (middle-mile) being the primary issue rural Arizonans face, the most promising ways to resolve this issue is through:

- Creation of a Broadband Development Agency – approved by legislature.
- Enabling a State Organization (e.g., GADA) to act as agent for projects involving telecommunications (as is done for other utilities and infrastructure projects).
- Streamline a statewide Rights-of-Way process.

These primary options, along with summaries of the others addressed above, should be fully developed as proposals to the Governor for consideration. As preparatory steps to that end, they should be presented to the following organizations to gain support.

- Alliance for the 2nd Century
- Northern Arizona Council of Governments
- The following State organizations:
- Government Information Technology Agency (GITA)
- Arizona Department of Commerce – Rural Development Division (ADOC), and Greater Arizona Development Authority (GADA)
- Arizona Corporation Commission

MAJOR MILESTONES - 5 YEAR PLAN

Let's lay out the path we want to take ... or we may never get there.

The efforts described below are critical to Northern Arizonans, particularly to members of NACOG and the Alliance for the 2nd Century, in our collective pursuit of telecommunications capabilities in our communities that will offer affordable broadband and many other new service offerings to local residents. In earlier chapters, many of the options, along with impediments to those options have been discussed.

The tasks and milestones presented below must be viewed as a multi-path approach to improving telecommunications and services in Northern Arizona. The most critical task as mentioned in many other parts of this plan is addressing the sheer lack of middle-mile resources. The fiber and/or microwave systems that support these links are very high cost. So developing methods to fund those first is critical, since they must exist before broadband access inside a community can begin (or expand).

In spite of the enormous focus on establishing middle-mile resources throughout Northern Arizona, many other activities must be planned simultaneously that address local and regional issues. Flagstaff, as the lead City engaged in creating this “total approach,” is the most proactive in addressing the telecommunications foundation issues. Therefore, this Plan will address the actions that must be taken not only on a local basis, but at the State level as well. In fact, the actions at the State level are most critical, since they involve the creation of a (one or more) funding mechanism(s) for middle-mile *fiber* infrastructure that largely does not exist today.

This chapter will address actions that GFEC will be engaging in from a Federal, State, and Local (or more appropriately, *regional*) level in that respective order. A brief summary of the issue(s) that must be addressed, along with a recommended set of actions will be described taking into account the dynamic changes relative to each issue.

FEDERAL ISSUES

A key issue relative to addressing any telecommunications issue must first give credence to the Federal regulatory body who administers national policy - i.e., the Federal Communications Commission (FCC). While the FCC was granted authority under the 1996 Telecom Act to administer all policy and regulatory (law) aspects of telecom services, their job has become increasingly difficult to manage largely because of the immense number of legal suits initiated since the Act was passed.

With limited budget and staff, the FCC is under fire from virtually every direction, and it seems that many of the court battles and appeals are destined for Supreme Court rulings. Key battles are not expected to be formally settled anytime soon, and the industry as a whole is expected to be tied up for at least the next two years. The fallout effects will likely take another two or three. In any event, with the focus on broadband in Arizona, the following key issues must be raised relative to Federal policies

requiring revision if rural Arizonans ever expect to attain broadband parity with major metropolitan areas.

RESTRUCTURE OF FEDERAL UNIVERSAL SERVICE FUND (USF)

The USF has long been a vehicle imposed by the FCC to help establish a central funding mechanism to ensure that life-line telephony can be established in rural areas where service would not otherwise be provisioned by carriers because of a "business case."

USF funds are disbursed back to the states in the form of E-rate grant funding. Government entities like school districts or Indian reservations submit annual grant applications, and funding may be used for a variety of applications including computer acquisitions and upgrades, network implementations, and funds to offset the cost of broadband internet access. In effect, the USF is contributing to maintaining the high cost of internet access charged by carriers who cannot or will not install more capable fiber into rural areas.

Arizonans in recent years have contributed substantially more to the USF than they have gotten back in E-rate grants, which makes Arizona a "donor" state. In fact, approximately 40% of Arizona's USF contributions (which annually have exceeded \$100M) have been awarded to other states' E-rate recipients. The residual funding taken from Arizona could be used to construct badly needed middle mile fiber throughout Arizona, thereby enabling ubiquitous broadband to become a reality.

These rules need changed, and the timing to change them couldn't be better. With Sen. McCain chairing the U.S. Commerce Committee which oversees the FCC, a substantial legislative effort to push for restructuring of the USF is in order now.

VOICE OVER IP (VOIP) REGULATION

The FCC, under the leadership of Michael Powell, has been openly vocal about the FCC's reluctance to impose any extensive regulation on VoIP. While VoIP has been classified as an "information service," many are beginning to argue that it should

be treated like any other "voice" service. The rapid entry by cable companies to begin offering internet-based VoIP services is just beginning to steal business from telcos, who complain vehemently about being over-regulated and having to compete on an uneven playing field because "information" services are *not* regulated (i.e., *taxed*).

In the background, the nascent migration of telephony away from tradition copper to VoIP is beginning to pick up speed. Industry leaders are even predicting a wholesale migration to VoIP by the year 2010, which would lay waste to the customer base and revenues from today's "twisted pair" phone customers. Telcos are already losing customers and revenues at a rate of 10-12% per year.

While the monthly revenues are certainly important to telcos, more important are the taxes collected at the state level that make up a substantial portion of state budget revenues. Migration to VoIP without any taxable revenues will devastate state budgets over time. Hence, state representatives as well as telcos are now beginning to promote regulation of VoIP. Time will tell, but the FCC will likely be forced to bow to regulatory necessity. Many of the cost advantages of migrating to VoIP from the "consumer" perspective will be quenched as a result. In spite of regulation, there are other technical advantages to migrating to VoIP, and the movement is expected to continue.

UNBUNDLED NETWORK ELEMENT (UNE)

The 1996 Telecom Act prescribed a "formula" for establishing *competition* in the marketplace by mandating that incumbent providers make elements of their networks available to competitive providers. The "line of demarcation" for network entry by a competitor was established to be at the "unbundled network element," though no thorough definition was provided in the Act. For the last nearly eight years this lack of definition has resulted in massive litigation between incumbent and competitive providers, many of whom did not have the ability to survive the long court battle and have filed for bankruptcy.

The FCC was similarly budget limited, and attempted to pass on the task of defining UNE to state regulatory commissions, who also were ill equipped to accept such a task. U.S. District Court recently ruled that the FCC cannot delegate the task, further complicating this dubious responsibility. It is now estimated that acceptable resolution of the UNE litigation will not likely occur for another two years. As a result, those aspiring to break into the competitive market could fail like many before them.

RF SPECTRUM

Wireless solutions that serve both telephony and data needs continue to expand. However, wireless solutions require RF spectrum (a radio frequency and defined bandwidth) that is not susceptible to interference by other systems. The FCC is working diligently to reallocate radio spectrum and make "channel space" available to implement wireless new service solutions.

The mandate to migrate to digital television by 2005 will open some frequency bands to accommodate these new systems and services, but these frequencies are not without cost. In fact, these spectrum allocations are managed tightly by the

FCC, and require significant up-front costs as well as license renewals on a periodic basis.

Next generation wireless systems that offer voice and/or data services (e.g., the 3G cellular networks), WiMax (802.16), Ultra Wideband (UWB), and others will all require dedicated RF spectrum to function. Some of these services will use licensed bands, some unlicensed so anyone may use them. Some will be implemented as point-to-point links, other as point-to-multipoint networks.

In any event, the FCC is struggling to identify how to best use RF spectrum to meet all the demands without impacting essential government, research and military system uses. While no direct and immediate action is required in this plan, it is of major interest because of the impact it may have to identifying solutions for rural Arizonans.

STATE

Through participation in the Arizona Telecommunications and Information Council (ATIC), GFEC recommends that Arizona adopt a strategy to accelerate deployment of advanced telecommunications services and affordable broadband Internet access throughout the State. These services are essential to the educational, economic and community development of Arizona's communities. Through initiatives such as TOPAZ, Community Telecom assessments, the Arizona Telemedicine Program and K-12 activities Arizona is progressing in broadband deployment, yet many of Arizona's communities still lack **affordable** broadband last-mile services such as cable modem, DSL, or fixed wireless.

In 2002 (the last year data was available) the Government Information Technology Agency

(GITA) estimated that less than half of Arizona's 87 cities and towns with populations over 500 have broadband available. Of the cities that have services, many still face middle and last-mile deficits, and/or experience higher service costs, making it unaffordable to end users. These un-served or underserved communities often have the highest unemployment and poverty rates, they are most in need of economic revitalization, yet they lack the necessary economic development infrastructure. These telecom services are also often unavailable to residents and critical public services including education, health care and government. Therefore, these communities have limited access to new services such as distance learning, telemedicine and e-Government, and they experience a lesser quality of life and a difficult business environment.

THE PROBLEM – NEED FOR MIDDLE MILE DEPLOYMENT

There are two primary telecom services required to deploy broadband into a community – **Last Mile** and **Middle Mile**. The **Last Mile** is the Internet connection between the Internet service provider (ISP) and businesses, homes, schools, etc. The **Middle Mile** is the high capacity trunk lines and associated infrastructure that connect communities to the Internet backbone points-of-presence generally in Phoenix and Tucson, and, in some cases, Albuquerque or Los Angeles. Last mile deployment of broadband is becoming more cost-effective, even in rural and underserved areas of the state with distributed populations. **A number of companies have expressed interest in providing last mile service in these areas, however, to deploy their networks and charge reasonable rates they must have access to sufficient and reasonably priced middle-mile connections.** There is an estimated \$80-\$150M requirement to address the middle-mile infrastructure deficiencies in Arizona. If a common middle mile infrastructure is not available, at reasonable rates, communities or last mile providers must construct their own middle mile infrastructure. This increases the last mile costs that can significantly increase the end users monthly rates.

BARRIERS TO MIDDLE MILE DEPLOYMENT

1. **Return on Investment:** Broadband deployment requires a balance between deployment costs, “affordable” monthly end user rates, and the length of time for the provider’s ROI, or Return on Investment. Today telecom providers are looking at an ROI requirement of 18 months - two years. Considering the cost of middle investment, this is often not a feasible model in rural and under served areas. Public and private organizations need some form of long term, low cost financing.
2. **Access to Rights-of-Way:** Federal, tribal, state and local Rights-of-Way issues such as multiple jurisdiction permitting, delayed application approvals, and unequal and prohibitive fees have been significant barriers and disincentives for deployment of services.

3. **Planning and Coordination:** While there are a number telecom related initiatives underway in Arizona, there is no coordinated statewide strategy. Through coordination and planning Arizona would more effectively leverage existing resources and be eligible for millions of grant dollars to benefit community development.

RECOMMENDATIONS

Arizona needs to remove barriers and develop public policies and market-driven strategies that will encourage competition, private-sector investment in, and rapid deployment of advanced telecommunications services and affordable broadband Internet access throughout the State. ATIC recommends the following initiatives:

1. Incorporate telecommunications as a critical infrastructure under GADA, the Greater Arizona Development Authority, in order to provide incentives for low cost, long term financing to encourage development of open and redundant, middle mile and last mile telecom solutions in the state.
2. Encourage the use of Project TOPAZ, the Telecommunications Open Partnerships for Arizona, to aggregate state and local government and private sector demand and procurement for telecom services.
3. Create an Arizona Telecommunications Planning Council that would produce a statewide telecom plan (incorporating regional plans), and facilitate coordination of the many statewide telecom infrastructure initiatives
4. Promote and support Regional/Community Telecommunications Assessments
5. Secure federal funding for telecom initiatives and provide state assistance to regions or communities of interest to identify, qualify, and apply for federal grants, subsidies and loans.
6. Expedite access to local, state, federal and tribal Rights of Way. Facilitate coordination and recommendations to expedite right of way permitting processes for last mile and middle mile inter-city/town transport.

INITIATIVE DETAILS

1. **GADA and Telecom Financing: Utilize the Greater Arizona Development Authority's (GADA) rule making authority to incorporate telecommunications as a critical infrastructure** in order to provide incentives for low cost, long term financing to encourage development of open and redundant, middle mile and last mile telecom solutions in the state. Where the law allows, owners of the network may be private, public or public/private partnerships. Networks using state or federal funds should be open on an equal basis to all.

Funding may come from sources such as nonprofit foundations, the federal or State Universal Service Funds, tax incentives, bonding, tribal gambling, E-rate, and other Federal programs including homeland security.

2. **Aggregate Demand and Procurement of Telecom Services:** Encourage the use of Project TOPAZ, the Telecommunications Open Partnerships for Arizona, to aggregate state and local government and private sector **demand** and **procurement** for telecom services. Topaz continues to be a primary vehicle to support public/private efforts to provision Rural Arizona with Broadband Infrastructure. As the State acts on behalf its own interests and in concert with other communities of interest, to deploy Broadband infrastructure, its agents will be mindful of local community needs as well as its own. The State will establish and utilize standards for systems and reporting procedures that will facilitate demand and procurement aggregation by agencies and political subdivisions. The State will insist that before State Telecom dollars are spent, demand and procurement aggregation policy has been implemented. To do this, agencies and Political subdivisions, as well as Telecom providers which use State Contracts for carrier services will need to comply with all reporting requirements within those contracts. Entities which choose not to use State Contracts are encouraged to respond positively to Topaz as a Statewide policy, and work with regional and statewide councils to aggregate their Telecom needs. Procurement organizations would provide expertise for negotiating terms, prices

and volume discounts, as well as commitments for increased deployment of broadband infrastructure. Subsequent agreements would then be forwarded to regional councils or Arizona Telecommunication Planning Council for monitoring.

3. **Statewide Telecom Planning and Coordination.** Create an Arizona Telecommunications Planning Council, ATPC, that would produce a statewide telecom plan and facilitate coordination of the many statewide telecom infrastructure initiatives such as TOPAZ, the School Facilities Board, Arizona Telemedicine Program, Universities and Community Colleges, NAUNET, SACCNet, CANAMEX Corridor, etc. The ATPC, along with Regional Councils, will provide the vision, framework and strategies for the development of a statewide telecom infrastructure. ATPC would be housed in the Commerce Department and be appointed from within state Government and from the Public.
4. **Regional/Community Assessments:** Last year the Legislature appropriated \$500K to enable regions or "communities of interest" to conduct telecom assessments that would identify community telecom assets, define Telecom requirements, craft regional solutions and find funding mechanisms for those solutions. Appropriations and resources should be provided for additional community assessments. These assessments should be sourced from and directed by GADA. Smaller communities of interest may join together and aggregate demand and procurement within the eleven Economic Development Areas defined by the Arizona Department of Commerce. Outcomes of these assessments should be reported to responsible parties and incorporated into the statewide plan.
5. **Federal Funding:** The State of Arizona should provide resources to secure federal funding for telecom initiatives and provide state assistance to regions or communities of interest to identify, qualify, and apply for federal grants, subsidies and loans directed at both the public and private sector.

Arizona lags far behind other states in the acquisition of Federal grants, subsidies and

loans for Broadband deployment. Currently, about \$8 Billion is earmarked nationally for Telecommunications subsidy and infrastructure deployment. Arizona's annual fair share, based on population alone, should be in the \$200-\$250 Million range. Over the last 5 years, Arizona's actual receipt from these programs is in the range of \$80 to \$120 Million annually. The State of Arizona needs to assist communities of interest in applying for these federal funds. The Arizona Telecommunication Planning Council, and regional councils, can be key players in this effort. Before State or local funds are used, all federal funding opportunities should be explored. Emphasis should be placed on funds that develop open infrastructure. We should explore having a resource person in Washington DC, and we should better utilize Arizona's

congressional and senatorial delegations in obtaining Federal funds.

Rights of Way: Expedite access to local, state, federal and tribal and Rights of Way. ATPC should facilitate coordination and development of recommendations for legislation and Executive directives to enable one-stop-shopping, consistent fees, and expedited right-of-way permitting processes for last mile and middle mile inter-city/town transport. Every effort will be made to see that State owned Rights of Way will be made available for Broadband deployment. State of Arizona laws and Executive Orders regarding Rights of Way issues will be the primary source of policy. Other governmental organizations and political subdivisions are to be encouraged to allow Rights of Way under their jurisdictions to be utilized at little or no cost for Broadband deployment.

LOCAL - NORTHERN ARIZONA

Key stakeholders in Northern Arizona - particularly the Flagstaff core group - face a number of challenges in establishing infrastructure and services that position them well to accommodate growth and economic development objectives.

The core group of stakeholders include:

- The City of Flagstaff
- Coconino County
- Northern Arizona University (NAU)
- Flagstaff Unified School District (FUSD)
- Coconino Community College
- The Navajo Nation
- The Hopi Nation
- The City of Page
- The City of Williams
- The City of Grand Canyon
- The City of Sedona
- Other lesser unincorporated cities/towns

A key issue which affects virtually all of these communities involves the sheer **lack of fiber infrastructure** upon which to ensure long-term telecommunications viability. While Flagstaff is reasonably well equipped with a fiber backbone to Phoenix, instances of fiber cuts have occurred

causing multi-hour outages that affect the whole northern region of the state. The Flagstaff Central Office acts as a hub to most northern Arizona communities' circuits, and the lack of redundant paths (failover circuits), any casualty to the Flagstaff-to-Phoenix fiber affects many cities.

Lack of redundancy is a primary objective GFEC will focus on as part of this plan. Efforts to date have resulted in the recent announcement by Qwest to install new fiber from Flagstaff to Winslow, where an existing fiber path to Albuquerque is in place but not currently lit. Completion of this connection would provide the basis for redundancy needed, and also provide a "reachable" fiber path for the improving telecommunications circuitry at the Navajo and Hopi reservations in the Northeast sector of the state. Barring no major complications, this new fiber lay may be completed by summer 2004. Long overdue.

STAKEHOLDER KEY ISSUES

The following table outlines key issues as discussed in consultations with IT directors of major stakeholders:

Stake Holder	Issue Description	Est. Cost	Who Invests	Priority Hi/Med/Lo
City of Flagstaff	a. Redundancy from Flagstaff b. Internet PoP in Flagstaff (\$30-50K/month recurring costs) c. Wireless user baseline in Flagstaff (\$8K)	\$6M \$600K \$8K	PI PI City	High High Med
Coconino County*	a. BB Internet to Munds/Kachina/Mtnaire/Winona b. Wireless Voice/data throughout county (requires infrastructure) c. Improved carrier infrastructure throughout county d. Fiber loop throughout Flagstaff – all key facilities e. Ability to get ISP services from Tier 1 providers	\$400K \$3M \$2M \$6M Negotiate	PI Joint PI City/County County	High High High High Med
NAU	a. Cost of local access links for 10K students b. Internet PoP in Flagstaff (~\$600K plus access recurring costs)	Negotiate \$600K	User PI	High Med
FUSD	a. Core router support (\$4K per year) b. Increase Bandwidth to schools - (\$300K/yr) c. Leupp connectivity (~\$50K + \$1K/month)	\$4K \$300K \$0K	FUSD FUSD FUSD	High Med Med
CCC	a. Broadband to Dine' building in Tuba City (\$5K + \$2K/month) b. Distance Learning Net (~\$2.5M + \$10K/month) c. Link costs and bandwidth alternatives (need 3-10 mbps) d. Internet PoP in Flagstaff	\$5K \$2.5M \$400K \$600K	CCC CCC/Grant PI PI	High Med Med Med
Library	a. Commspeed to Williams library (\$40 per month) b. Remote library accesses (OnSat? approximately \$1200/month) c. Fredonia broadband (service from XpressWeb in Knabb, UT) d. Internet PoP in Flagstaff	\$40/mo. \$1200/mo. \$100/mo. \$600K	Library Library Library PI	High High Med Med
Navajo Nation	a. Access to broadband trunks (~\$500K + \$10K/month) b. Schools/Chapter houses networked (~ from \$2M to \$8M....) c. Telemedicine net upgrade (~\$2M)	\$500K \$7M \$2M	Nation Nation/Grant Nation/Grant	High High High
Hopi Nation	a. Access to broadband trunks (~\$500K + \$10K/month) b. Telemedicine network upgrades (~\$1.2M) c. Create Hopi Telecom (~\$10M)	\$500K \$1.2M \$10M	Nation/Grant Nation/Grant Nation/Grant	High High High
City of Williams	a. Broadband Provider(s) (commspeed entry) b. Fiber access in the Central Office (~\$300K carrier invest) c. Cellular Coverage (carrier upgrades - ~\$450K/tower)	\$40/mo. \$300K \$450K	User PI PI	High High Med
City of Page	a. Access to broadband trunk (Qwest upgrade ~\$1.2M) b. Cost of broadband access (competitor entry once a. is done) c. Access to fiber (carrier invest - ~\$6.5M)	\$1.2M \$40/mo. \$6.5M	PI User PI	High High Med

PI = Provider (or “carrier”) investment is required rather than cost being imposed upon a stakeholder or user.

Two issues prevalent in the above table are:

1. Shortage or inadequacy of infrastructure (and resultant high costs), and
2. Unlicensed band wireless interference issues.

In addition, because of the extent of the impact, it is worthwhile expanding on the criticality of some of these issues in order to encourage immediate resolution.

City of Flagstaff. The City’s principal issues include the establishment of redundant central office capability to prevent multi-hour telecommunications outages in Northern Arizona, and the establishment of an internet Point of Presence (PoP) to reduce the cost of internet trunk charges that are usually “distance sensitive.” The cost of these upgrades are estimated at over \$6M largely because of the requirement for a major alternate-path fiber lay separate from the existing route to Phoenix. This added fiber would also create the potential for the installation of an internet PoP in Flagstaff if Return on Investment (ROI) goals of potential carriers is considered positive. This would reduce by 15-25% the cost of bulk internet services throughout the Northern Arizona area.

The other issues involved the growing use of unlicensed wireless systems in Flagstaff, and the inherent signal interference it causes as more and more users deploy these systems. Since they share the same frequency and sometimes “channel”, the effect is a significant increase in RF “noise” that these units must process and perform “error correction,” making the systems operate in a degraded (less than full rate) state. Knowing how many systems exist, where they are located, and what channel is being used by the operator helps minimize the impact on the City’s wireless operation. A spectral analysis would likely cost approximately \$8K.

Coconino County. The County is actively engaged in pursuing extensions of its existing broadband connections, and intends in the near future to press for improved carrier infrastructure to serve not only the Flagstaff County functions in town, but also throughout the County as well. These are ambitious goals considering the cost of these infrastructure improvements and reluctance of carriers and providers to do them at their own expense. Estimates to provision fiber and/or microwave resources capable of establishing the County’s broadband network needs may easily cost \$10M or more depending on what partnerships might be arranged with the City and other stakeholders, or borne by carrier investments.

Once the primary trunks are in place, establishing a full-function wireless capability is feasible, but the trunk capacity must be pursued first. And

establishing that trunk capacity to currently unserved areas of Munds Park, Kachina, Mountainaire and Winona in order to deliver a robust broadband capability in these areas. This can be accomplished using microwave trunks initially, but the eventual incorporation of more permanent fiber is essential for the long-term.

Typical costs for fiber lays for planning purposes are approximately:

In-City:	\$60K per mile
Inter-City:	\$25K per mile
Aerial:	\$12-20K per mile

not counting Right-of-Way (ROW) or recurring costs. In addition, the raw cost of fiber varies generally between \$1.50 to \$2.50 per foot depending on stand count.

Every opportunity to reduce ROW costs should be considered by both the City and County to help spawn a willingness by providers to provision.

Coconino Community College. CCC’s interest in extending its classware to remote facilities throughout the County. All too often, the telecom resources are either unavailable or unaffordable. One alternative CCC has is to pursue grant opportunities that could create a microwave-based solution to establish this connectivity which could cost upwards of \$2.5M, or to monitor the activities of Qwest’s (and other provider) upgrades that should permit the establishment of affordable local connections for these remote facilities.

Creation of an internet PoP is also a common interest with the City, County and others since it would further reduce the cost of bulk internet access that supports all CCC’s locations.

FUSD. Two major issues exist within FUSD that deserve special consideration and immediate resolution. First, the lack of maintenance support for the core Cisco router that provides aggregate connectivity to the internet for all FUSD schools must be resolved as soon as possible. At this point, any hardware and/or software casualty this device should suffer would terminate all internet access to all schools. The estimated \$4000 per year needed to establish a maintenance contract should be diverted

within existing school budget, and provided for in all future budget considerations.

A second and also pressing issue is that bandwidth provided by the State's School Facilities Board (SFB) contract calls for a single T1 into each school. Given the number of users who access the internet from many schools, a single T1 is not considered adequate. Accordingly, an ad hoc committee should be established to review bandwidth deficiencies, outline alternatives to upgrade current connectivity, and provide feedback to the SFB regarding increased requirements.

City and County Wireless. Both the City of Flagstaff and Coconino County make use of unlicensed wireless radio systems to establish critical connectivity between two or more sites in Flagstaff. While the cost effectiveness and simplicity of using these systems demonstrate many advantages, the use of unlicensed spectrum-based systems brings with it the issue of "interference," since any number of users are permitted to use radios in the same frequency space (and channel). In addition, no user may be forced legally to stop interfering use. As a result, both City and County offices, as well as the library, have suffered heavy degradation to data circuits interconnecting local sites. In addition, the typical use of 802.11 (WiFi) equipment also presents an issue with security that warrants attention sometime soon.

It is recommended that near-term budget considerations attempt to identify either a licensed wireless technology, or land-line alternative. Next-generation 802.16 equipment will be entering the market later this year - in both licensed and unlicensed bands - that would eliminate the wireless fratricide currently experienced.

City of Williams. As a result of the GFEC Telecom project, the City of Williams is now provisioned with broadband service capability by the introduction of CommSpeed's wireless installation. Additional work is ongoing by Qwest to provision DSL within the City of Williams as well, and may

begin service by the end of 2004. Between these two solutions, broadband will be available to local government as well as residents at an affordable price.

City of Page. The City of Page has long been plagued by being served by a trunk that extends from the City of Flagstaff's central office that is traffic-wise full. However, Qwest is in the midst of re-provisioning this trunk with equipment that is expected to triple the existing trunk capacity, and will have available the excess bandwidth necessary to inaugurate broadband services from one or even more providers - using either wired or wireless offerings. This capacity should be in place in early 2005.

Navajo Nation. The Navajo are actively engaged in the development of plans to build their own network. The newly formed Navajo Telecom Regulatory Commission is in the midst of establishing policies and processes that should offer opportunities for broadband service introduction throughout the Navajo Nation, and realize the benefit of capturing access to broadband resources from a variety of points just outside the Nation's boundaries in an affordable. Long-term plans are being formulated also to develop a core fiber strategy that can support the Nation in its pursuit of economic development goals.

Hopi Nation. The Hopi Nation is actively engaged in taking control of their own broadband destiny through the creation of its own municipal utility called Hopi Telecommunications. In coming months, decisions will be made whether to acquire the capital assets of the existing CenturyTel provider as the foundation for this utility, or to build largely from scratch a Hopi-wide network that can provide the broadband service capacity for their future.

A summary of GFEC's principal thrusts and approximate timeframes are outlined in the following table.

QTR/ YEAR	STATE	LOCAL	OTHER
2Q04	<ol style="list-style-type: none"> 1. Establish process within GADA for telecom project bonding. 2. Schedule briefings to communities on GADA process - emphasizing regional cooperation. 3. ATIC participation; develop additional legislative proposals to expand middle-mile funding sources within GADA as part of Joint Legislative Committee on Telecommunications (JLCT). 4. Support development of a universal briefing to communities to discuss broadband development alternatives. 	<ol style="list-style-type: none"> 1. Assist as requested with airpark fiber ring project. 2. Publish Telecom Plan for all key stakeholders for review and comment. Finalize. 3. Assist Qwest with gaining right-of-way approval on the Navajo Nation for use of Preston Mesa/Jack's Peak microwave upgrade from DS-3 to OC-3 connectivity to Page. 4. Coordinate with CCC on holding a regular "Telecom Seminar" Flagstaff 5. Active involvement in Rough Rock School District upgrade plans to bring establish VoIP system to Navajo reservation (Optegra-Lockheed Martin). 6. Host discussions with AT&T and Telespectra regarding installation of internet access PoP in Flagstaff central office. 6. Community briefings. 	<ol style="list-style-type: none"> 1. Review key stakeholder needs, issues and potential requirements changes for incorporation into long-term plans. 2. Host follow-on meeting with Qwest to address redundancy issues and impacts incurred during Jan 9 and July 9 outages. 3. Investigate in detail the use of 802.16 wireless broadband technology and develop report and brief. 4. When/if tasked, provide IT consultant services to City of Flagstaff to assist building long term IT plan. 6. Outline telecom overview for Navajo Infrastructure conference in Farmington NM - May 11/12 7. Participate in Navajo Telecom Regulatory Commission meetings as requested.

3Q04	<ol style="list-style-type: none"> 1. Pursue additional ADOC CTA opportunity for work not completed by initial CTA (wireless baseline?) 2. Assist with definition of Broadband Service Fund as part of JLCT. 3. Assist with legislative efforts to expand GADA role as a bond authority for telecom infrastructure. 4. Assist GITA with further development of the rural telecom plans and policy. 5. Assist ACC with suggestions on policy to separate commercial and wholesale elements of ILECs. 6. Governor's Rural Development Conference 	<ol style="list-style-type: none"> 1. Continue to assist as needed with Airpark fiber project. 2. Engage with and encourage at least 3 new potential providers of services in Northern AZ. 3. Continue ATIC board support in formulation of strategy and policy for Northern AZ. 4. Telecommunications and Networking Seminar at CCC. Primary focus - wireless technologies. 5. Work with Optegra to define solution for wireless expansion for Navajo/Hopi. 6. Support briefings to the Arizona ITA. 7. Community briefings. 	<ol style="list-style-type: none"> 1. Meet with candidate competitive service providers formulating a telco hotel strategy in Flagstaff. 2. Begin project to evaluate and document use of unlicensed wireless spectrum in Flagstaff to use as a baseline for new service providers. 3. Evaluate new opportunities for competitive (lower cost) service to N. AZ communities. 4. Participate in Navajo Telecom Regulatory Commission meetings as requested. 5. Review and build updates for 2005 issue of Telecom Plan.
4Q04	<ol style="list-style-type: none"> 1. Coordinate infrastructure installation priorities for N. AZ 2. Address access costs of infrastructure to support telemedicine and distance learning (CCC & NAU) 3. Work with GITA on updating critical infrastructure maps of AZ. 	<ol style="list-style-type: none"> 1. Revisit possibilities for City to consider Traffic Signal upgrade.. 2. Coordinate expansion of DSL to gapped areas in Flagstaff. 3. Continue discussions with CableVision regarding provisioning Airpark fiber. 4. Create web-based version of Telecom Plan. 5. Community briefings. 	<ol style="list-style-type: none"> 1. Coordinate with existing and new providers for VoIP entry into N. AZ market. 2. Formulate business model strategy for Telco Hotel. 3. Review new Federal mandates and opportunities for funding and expanding critical infrastructure. 4. Review and build updates for 2005 issue of Telecom Plan
1Q05	<ol style="list-style-type: none"> 1. ATIC board - assist with State-wide telecom plan. 2. Assist GITA/ACC as needed in refining policies and plans for rural broadband initiatives. 	<ol style="list-style-type: none"> 1. Update the N AZ Telecom Plan and redistribute to stakeholders. 2. Provide "Where we are" update to stakeholders. 	<ol style="list-style-type: none"> 1. ILEC and competitive provider discussions on creating Service Level Agreements. 2. Coordinate service aggregation strategy
2Q05	<ol style="list-style-type: none"> 1. Review status of State agency Broadband activities. 2. Provide "Where we are" feedback presentation to GITA and ADOC. 	<ol style="list-style-type: none"> 1. CableVision fiber to alt entrance to airport. 2. Review overall networks of City & County and discuss ways to reduce cost / increase capabilities. 	<ol style="list-style-type: none"> 1. Engage with providers on VoIP offerings for Flagstaff businesses. 2. Review and build updates for 2006 issue of Telecom Plan.

3Q05	1. Review status of legislation and ongoing projects for impacts and/or follow on activities in N. AZ.	1. Baseline successes, and identify gapfill requirements for incorporation into updated Plan.	1. Engage key stakeholders; identify critical issues and incorporate into Telecom Plan update
4Q05	Under development	Under development	Under development
1Q06	Under development	Under development	Under development

Recent Accomplishments:

- CommSpeed's wireless MMDS service initiation in Flagstaff (including both residential and business access - offering residents double the speed of existing cable and DSL offerings at saving of \$10-\$15 per month)
- Initiation of discussions with AT&T and Telespectra (potentially, other carriers) regarding installation of a primary internet access Point of Presence (PoP) in the Flagstaff Central Office. Once completed, business and government subscribers will be able to significantly reduce broadband access costs by eliminating the "distance-sensitive" trunk charges currently applied by carriers to transport internet traffic to the PoP in Phoenix.
- Enticement of Qwest to begin installation of fiber from Flagstaff to Winslow.
- Expansion of CommSpeed network to include high speed business class wireless access in Flagstaff, and expansion into Williams.
- Evaluation of service options between W.L. Gore campuses that - once complete - will result in savings exceeding \$100K per year.
- Recent expansion of Qwest DSL offering into Doney Park and North Flagstaff.
- Wrote GADA legislation establishing the foundation for funding middle-mile infrastructure to Arizona rural communities.
- Provide inputs for City leaders for Washington visit, addressing need for restructure of USF funding.
- Assist with selection of County IT Director.

SUMMARY

Key elements of near-term GFEC work are intended to focus on ways to resolve the following critical issues first:

- Establish funding mechanism for broadband infrastructure throughout Northern Arizona.
- Resolve longstanding redundancy issue in trunks between Phoenix and Flagstaff.
- Provide direct support to the Alliance and community stakeholders on telecom and network-related issues
- Support development of the Fiber Ring at the Airpark. (Use wireless broadband as an interim support method).
- Continue to pursue the entry of alternative (read: *competitive*) providers into Flagstaff and other Northern Arizona communities as a means of keeping costs down.
- Move forward with concepts that aggregate services for key businesses and telecom consumers in Northern Arizona as a means of minimizing broadband access costs while maximizing broadband capabilities.
- Exploit developments in Voice Over IP technologies and providers as a means of establishing service offering(s) for VoIP in Flagstaff (and potentially other communities).

APPENDIX



Extremely Useful Stuff

TECHNOLOGY OVERVIEWS

- A [Digital Subscriber Loop Overview](#)
- B [Cable Modem Overview](#)
- C [Wireless Technology Overview](#)
- D [Fixed Wireless & Satellite Technology Overview](#)
- E [Optical Technology Overview](#)
- F [Legacy Copper Technology Overview](#)

Arizona Service Provider Listings

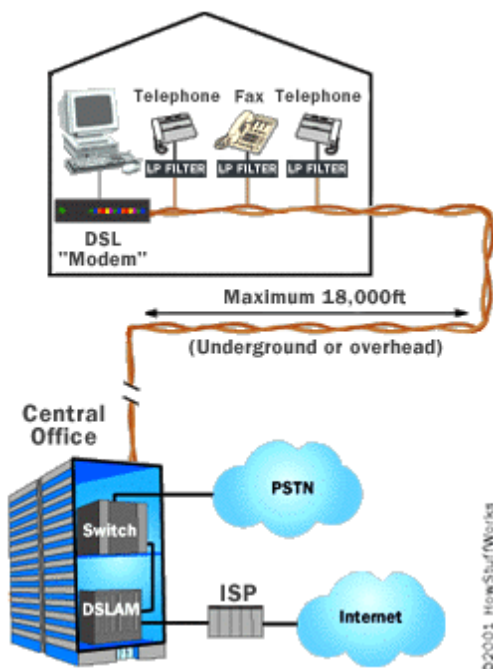
- G [Telecommunications Service](#)

DSL DEFINITION AND OVERVIEW

Digital subscriber line (DSL) is a newer modem technology that permits reuse of existing twisted-pair telephone lines as access paths for high-speed digital communications. The most common form of DSL is ADSL, but it only one of the many forms within the xDSL family as we will see. We will look at it first, since it the most widely deployed.

OVERVIEW

ADSL can transmit downstream (from Central Office toward subscriber) to over 8 Mbps - depending on the distance involved. This is enough bandwidth to provide Internet access, video-on-demand, and LAN access at fairly high speed, though most residential deployments limit downstream bandwidth to a user's home to typically 256-384 Kbps. In interactive mode it is transmit up to 1024 kbps upstream, though this bandwidth is also limited to between 64 and 128 Kbps. The advantages of DSL over traditional dial-up service include not only a speed increase of five to thirty-fold, but DSL is an "always on" modem connection. Most communities in the U.S. over 20,000 in



population either have deployed ADSL, or will likely in the near future since equipment costs have come down significantly.

While ADSL has long promised to be nothing less than an ubiquitous access network that can provide reasonably good multimedia (including full-motion video) to the entire country, it is not without problems. Engineering issues as well as business issues must be addressed by providers of ADSL before service providers commit to deploy ADSL service.

As with any modem technology, DSL modems come in "pairs." For each modem in a residence or business, there is a mirror device (modem) at the central office, generally integrated into line cards of racked equipment called a DSL Access Multiplexer - or DSLAM, as shown here.

By design, ADSL uses the same wire "pair" to connect to both high-speed data as well as conventional voice - separated in frequency as shown below.

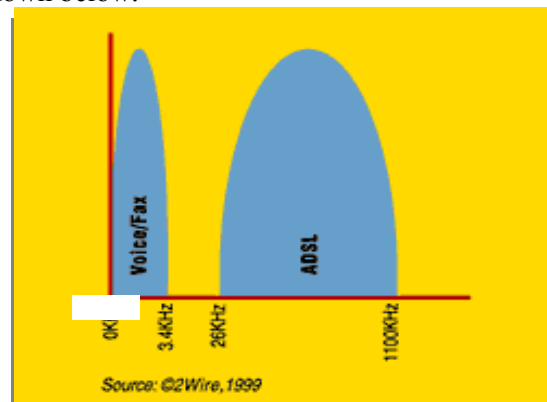


Figure 1. Asymmetric Digital Subscriber Line (ADSL) sends data at frequencies of 26KHz to 1100KHz, maintaining analog voice service on the same copper wire in the 0KHz to 3.4KHz range. Symmetric DSL (SDSL) uses the entire frequency of the line for data and does not coexist with analog voice service.

To provision service, the two modems are connected using the existing telephone lines. They "talk" to each other to establish their connection, performing tasks in the process like:

- Providing network address information
- Performing initial link error analyses
- Establishing uplink/downlink speeds

- ADSL typically performs as indicated in Table 1 if the existing copper is relatively new.

Data Rate (Mbps)	Wire Gauge (AWG)	Distance (ft)
1.5–2.0	24	18,000
1.5–2.0	26	15,000
6.1	24	12,000
6.1	26	9,000

Table 1. ADSL data rates as a function of wire and distance.

Other Forms of DSL: ADSL, VDSL, VADSL, HDSL, DSL, SDSL, BDSL, G.SHDSL - enough for several dizzy spells. Most of these acronyms have relatively clear definitions, but they often suffer confusion, with one another as well as with other acronyms. Table 2 helps to define the most commonly deployed of these terms. Rather than put them in alphabetical order, they are arranged in chronological sequence of introduction.

Table 2. Copper Access Transmission Technologies

Name	Meaning	Data Rate	Mode	Applications
V.22 ¹ V.32, V.34 V.90	Voice Band Modems	1200 bps to 56,600 bps	Duplex ³	Serial Data communications
DSL	Digital Subscriber Line	160 kbps ²	Duplex	ISDN service Voice and data
HDSL ⁶	High data rate Digital Subscriber Line	1.544 Mbps ⁴ 2.048 Mbps ⁵	Duplex Duplex	T1/E1 service Feeder plant, WAN/LAN/server access
SDSL	Single Line Digital Subscriber Line	1.544 Mbps - 2.048 Mbps	Duplex Duplex	Same as HDSL plus access for symmetric services
ADSL	Asymmetric Digital Subscriber Line	1.5 to 9 Mbps 16 to 640 kbps	Down ⁸ Up	Internet access, video on demand, simplex video, LAN access, multimedia
VDSL ⁷	Very high data rate Digital Subscriber Line	13 to 52 Mbps 1.5 to 2.3 Mbps	Down Up ⁹	Same as ADSL plus HDTV - the 52 Mbps; < 1000 m.

- Designations are not acronyms, but CCITT recommendation numbers
- 192 Kbps divides into two B channels (64 kbps), one D channel (16 kbps) and link administration.
- "Duplex" means data of the same rate both upstream and downstream at the same time.
- Requires two twisted-pair lines
- Requires three twisted-pair lines
- A new system called SDSL, for Single Line DSL, operates at 1.5 or 2.0 Mbps duplex over one line
- Also called BDSL or VADSL, VDSL is ANSI and ETSI designation.
- "Down" means downstream, from the network to the subscriber. "Up" means upstream.
- Future VDSL systems may have upstream rates equal to downstream, but on much shorter lines.

The typical "Central Office," or CO, is equipped with racks of equipment as shown in the following photograph. The DSL Access Multiplexer, or DSLAM, generally supports an expandable modem bank capable of hosting up to [at least] a few thousand DSL subscribers.

The CO is supported by many inter-exchange high-speed connections that may be copper, fiber, or even

wireless point-to-point circuits. When loop lengths exceed the 18,000 foot maximum for deploying DSL, often the DSLAM equipment is positioned into remote equipment facilities closer to the neighborhoods they are meant to serve, and data is "trunked" back to the main CO for aggregation with other high-speed circuits dedicated to internet or other primary network access.



DSL -- DIGITAL SUBSCRIBER LINE (OR LOOP)

The basic acronyms for all DSL arrangements came from Bellcore whose focus for many years was engineering and technology standards. So we may blame them for the basic confusion regarding the various forms of DSL. In general, DSL signifies a modem, or a modem pair actually, and not a line at all. A modem pair applied to a line creates a digital subscriber line. When a telephone company buys DSL, or e.g., ADSL, or HDSL equipment, it buys modems, quite apart from the lines, which they already own. This confusion becomes quite important to avoid when we talk about deployment costs. A "DSL" is one modem; a line requires two, the second of which is located in the DSLAM at the telco central office.

The DSLAM's function is to act as a modem "bank", and aggregate the data connections of many modems into a very high speed data trunk that connects to a service providers high speed data switches and routers, and [almost always] the internet. as shown in Figure 3 below.

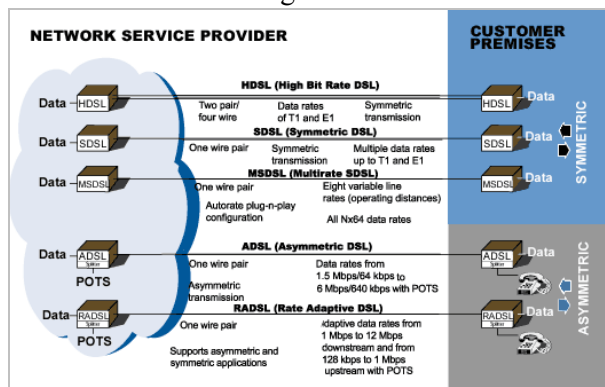


Figure 3. Common DSL net variants

DSL modems are different from traditional dial-up modems like the 56 Kbps ones we are all familiar with. They are considered a "dedicated" network device, and are equipped with a Media Access Control (MAC) address that identifies [and qualifies] the device for use on a specific service provider network. Secondly, the DSL modem is an "always ON" device, and requires no dial-up process - it will automatically establish its connection to the DSLAM modem. Initiation involves a protocol negotiation process where the modems - under the control of the DSLAM end modem - establish the best achievable operational rate with minimal expectation of link errors for the inherent loop length. They automatically adjust their own link parameters to optimize transmit and receive power levels (signal to noise ratio), up and downstream data rates, error coding, and a variety of parameters that establish the optimum data transfer in both directions. Each individual modem on the network may also be monitored or controlled from a central location by a network management workstation. This network manager may also be used to set or preset how any modem will function on the provider network and provide direct control of a modem in the event any user should experience network difficulties.

Virtually all recent (aka, "standards compliant") DSL modems use a specific signal modulation and coding method called DMT - or Discrete Multi-Tone. This particular modulation method was selected because it causes the least amount of inter-wire-pair interference across bulk cabling. For reference purposes, early T1 (DS-1) equipment used a modulation technique called Alternate Mark Inversion (AMI) which caused so much inter-wire interference, no more than one T1 could be connected within a bulk telephone cable. Hence, recent T1 implementations actually employ HDSL modems which provide equivalent 1.544 Mbps link rates, but using Carrierless Amplitude and Phase (CAP) modulation - which causes far less noise in existing bulk copper cable systems.

HDSL - HIGH DATA RATE DIGITAL SUBSCRIBER LINE

HDSL is simply a better way of transmitting T1 or E1 over twisted pair copper lines. It uses less

bandwidth and requires no repeaters across its 12,000 foot usable loop length (@ 24 gauge wire). Using more advanced modulation techniques, HDSL transmits 1.544 Mbps or 2.048 Mbps in bandwidths ranging from 80 kHz to 240 kHz, depending upon the specific technique, rather than the greedy 1.5 MHz absorbed by AMI.

Typical applications include PBX network connections, cellular antenna stations, digital loop carrier systems, inter-exchange POPs, Internet servers, and private data networks. As HDSL is the most mature of DSL technologies with rates above a megabit, it will be used for many early-adopter premises applications for Internet and remote LAN access, but may give way to ADSL and SDSL in instances where cost is a prime consideration. HDSL, when implemented as a T1, can still command rates of \$100 to as high as \$700 per month.

SDSL - SINGLE LINE DIGITAL SUBSCRIBER LINE

On its face SDSL is simply a single line version of HDSL, transmitting T1 or E1 equivalent signals over a single twisted pair, and (in most cases) operating over POTS. So a single line can support POTS and T1/E1 simultaneously. However, SDSL has the important advantage compared to HDSL that it suits the market for individual subscriber premises which are often equipped with only a single telephone line. SDSL may be desired for any application needing symmetric access - such as higher uplink speeds for web servers and power remote LAN users), and it therefore complements ADSL (see below). It should be noted, however, that SDSL will not reach much beyond 10,000 feet.

ADSL - ASYMMETRIC DIGITAL SUBSCRIBER LINE

ADSL followed on the heels of HDSL, but is really intended for the last mile into a customer's premises. As its name implies, ADSL transmits an asymmetric data stream, with *much* more going downstream to the subscriber and much less coming back. The reason for this has less to do with transmission technology than with the cable plant itself. Twisted pair telephone wires are bundled together in large cables. Fifty pair to a cable is a typical configuration

towards the subscriber, but cables coming out of a central office may have hundreds or even thousands of pairs bundled together. An individual line from a CO to a subscriber is spliced together from many cable sections as they fan out from the central office (Bellcore claims that the average U.S. subscriber line has twenty-two splices). Alexander Bell invented twisted pair wiring to minimize the interference of signals from one cable to another caused by radiation or capacitive coupling, but the process is not perfect. Signals do couple, and couple more so as frequencies and the length of line increase. It turns out that if you try to send symmetric signals in many pairs within a cable, you significantly limit the data rate and length of line you can attain because of inter-wire noise. In fact, as the number of DSL subscribers increases across a common bulk cable, there comes a point of serious signal degradation to all users whose lines are in the same bulk cable. This effect is quite noticeable once the level of subscribership reaches around 50% of the used pairs.

Luckily, the preponderance of target applications for ADSL services are asymmetric. Video on demand, home shopping, Internet access, remote LAN access, multimedia access, specialized PC services all feature high data rate demands downstream, to the subscriber, but relatively low data rates demands upstream. MPEG movies with simulated VCR controls, for example, require 1.5 or 3.0 Mbps downstream for acceptable full-screen video viewing, but can work just fine with no more than 64 kbps (or even 16 kbps) upstream. The IP protocols for Internet or LAN access push upstream rates higher, but a ten to one ratio of down to upstream does not compromise performance for most residential applications where very little high-volume content is provided into the network from the home.

ADSL has a range of downstream speeds depending on distance (and cable "cleanliness"):

- Up to 18,000 feet 1.544 Mbps
- 16,000 feet 2.048 Mbps
- 12,000 feet 6.312 Mbps
- 9,000 feet 8.448 Mbps

Upstream speeds range from 16 kbps to 640 kbps. Individual products today incorporate a variety of

speed arrangements, from a minimum set of 1.544/2.048 Mbps down and 16 kbps up to a maximum set of over 8 Mbps down and 640 kbps up. All of these arrangements operate in a frequency band above POTS (see Figure 2), leaving POTS service independent and undisturbed, even if a premises ADSL modem fails. For the higher data rate ADSL implementations, it is common to install a small splitter-filter device to help eliminate audible noise induced to the POTS phone in the home. Noise in the telephone has been a significant issue in the deployment of ADSL, since it forces providers to make service calls (truck rolls) to fix the problem.

Most ADSL implemented to date has used Asynchronous Transfer Mode (ATM) as its fundamental link protocol. This makes it very suitable for easy integration across international core networks which use ATM as the fundamental protocol for bulk aggregated data traffic. ATM has distinct advantages in terms of Quality of Service (QoS) features that are critical to applications involving voice and video where smooth flow is critical. In most instances today though, the data transported is encapsulated in traditional ethernet form (Internet Protocol - IP, using either TCP or UDP as the delivery protocol). In IP-based networks, QoS features are still evolving, so impacts to voice and video are very common. This is changing, and in controlled network environments IP-based protocols are used effectively for voice and video. Since the implication of ATM adds significant cost to equipment, recent trends in DSL are to implement IP as the fundamental link protocol, eliminating ATM altogether. This will permit direct connection through lower cost routers and switching equipment to constitute the network, rather than having to incorporate much higher cost ATM switch gear.

G.SHDSL - ALL NEW AND GAINING POPULARITY

G.SHDSL is a new international standard for single-pair, high-speed DSL, as defined in the ITU-T Standard G.991.2. Unlike asymmetric DSL, which was designed for residential applications in which more bandwidth is delivered downstream (to the house) than is available upstream (to the Internet),

G.SHDSL is symmetrical - offering 2.3M bit/sec in both directions.

This makes G.SHDSL better-suited for business applications, which require higher-speed bandwidth in both directions. G.SHDSL combines the positive aspects of existing copper-based, high-speed communications with the benefits of increased data rates, longer reach and less noise.

Today's North American private line, frame relay and Internet services for business applications typically are served by T-1 - 1.544M bit/sec access lines. T-1 technology moved from Alternate Mark Inversion/Bipolar 8 Zero Substitution (AMI/B8ZS) coding to high-bit-rate DSL (HDSL) in the early 1990s. T-1 AMI/B8ZS was a two-pair (four-wire) technology with limited reach, requiring a signal regenerator (repeater) 3,000 feet from the central office and another every 6,000 feet.

T-1 repeaters are expensive to purchase, install and maintain, but are required to deliver T-1 service. HDSL applied the new ISDN-based modulation scheme - 2 Binary 1 Quaternary - to T-1 communications, which resulted in transmission up to approximately 9,000 feet without the need for repeaters. North American telephone companies quickly migrated to HDSL to save the cost of one or two repeaters.

In the rest of the world, business applications are typically served by E-1, at 2.048M bit/sec. Europe, where business customers usually are within reach of the central office, has not migrated as quickly to HDSL transport.

But Europe, along with the rest of the world, did want to take advantage of the advances being made in the DSL world and, through the International Telecommunications Union, sanctioned the specification of G.SHDSL to provide increased bandwidth with reduced noise.

Today, U.S. business DSL lines are predominantly asymmetric DSL (ADSL) - the residential technology with deliverable data rates that cap out at 384K bit/sec for symmetrical service. North American telephone companies are evaluating G.SHDSL technology for Internet services targeted at small to midsize companies, offering data rates of

786K, 1.544M and 2.3M bit/sec. These Internet services will offer a reduced service-level agreement compared with T-1 or E-1 services, at a lower monthly cost.

Four factors are driving the interest in G.SHDSL:

- Standardization: The industry needs a higher-speed digital transport service for business applications. HDSL was never adopted as an international standard. Symmetric DSL - introduced as the DSL service for businesses in the late 1990s - never became a standard and interfered with the residential ADSL service because it was spectrally incompatible (very noisy). G.SHDSL is positioned for deployment in Internet and T-1/E-1 infrastructure applications because of its international standardization.
- Improved data rate: G.SHDSL offers a two-wire standard operating at 2.3M bit/sec and four-wire standard operating at 4.6M bit/sec. HDSL, when initially introduced, provided 1.544M bit/sec with four wires. G.SHDSL offers roughly three times that and, when compared with the newer HDSL2 and HDSL4 services (1.544M bit/sec over two wires or four wires), still provides significantly more bandwidth.
- Improved reach: G.SHDSL generally provides 20% to 30% increase in reach over HDSL at the same deliverable data rates. Additionally, when G.SHDSL multilink technologies are used, such as four-wire, Inverse Multiplexing for ATM and permanent-virtual-circuit bonding, G.SHDSL's reach is more than double HDSL's.
- Spectral compatibility: G.SHDSL is spectrally compatible with ADSL, causing little noise or crosstalk between cables. Therefore, G.SHDSL services can be mixed with ADSL in the same cables without much - if any - interference.

G.SHDSL quickly has caught on in European markets, and the major North American local exchange carriers will roll it out soon.

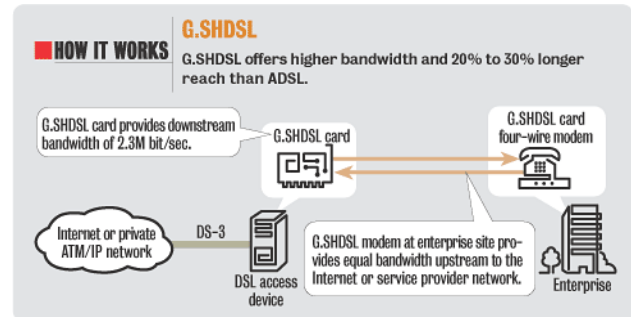


Figure 4: G.SHDSL functional description

VDSL -- VERY HIGH DATA RATE DIGITAL SUBSCRIBER LINE

VDSL began life being called VADSL, because at least in its first manifestations, VDSL is an asymmetric link like ADSL, but at data rates far higher and significantly *shorter lines*. General standard were just recently introduced which again leverage the use of DMT modulation - but giving credit also to all the existing CAP modulated VDSL equipment already in deployment. The following are common VDSL downlink speeds:

- 12.96 Mbps @ 4,500 feet of wire
- 25.82 Mbps @ 3,000 feet of wire
- 51.84 Mbps @ 1,000 feet of wire

Upstream rates fall within a suggested range from 1.6 Mbps to 2.3 Mbps. In many ways VDSL is simpler than ADSL. Shorter lines impose far fewer transmission constraints, so the basic transceiver technology is much less complex, even though it is ten times faster. VDSL only targets ATM network architectures, and must have a complex and diverse core of fiber into neighborhoods in order to place the central office modems within a few thousand feet of homes served. The modem bank which is coupled to an ATM switch and interface is commonly referred to as the "optical network interface, or ONI." These devices aggregate the individual home connections into a bulk fiber transport link back to the main central office. Passive Optical Network technology, or PON, is most commonly used for distribution into the neighborhoods.

The VDSL picture clouds under closer inspection. In public switched network ATM has not begun deployment yet, would take decades to become

ubiquitous, and the expense would be very high because of the vast amount of fiber required to establish the transport paths. Of all the DSL forms, VDSL is the most costly to deploy - costing 3 to 10 times what ADSL is today. But for very high speed service in areas where populations are dense (e.g., multi-family units, high rises, etc.) it is an excellent choice given that fiber is available in close proximity, it permits use of the existing copper without rewiring each unit - which can become a very expensive part of broadband deployments.

DSL SERVICE OFFERINGS - AN OVERVIEW

FINDING AN ISP

For many people, the decision to go subscribe to DSL is prompted by a direct mail or e-mail contact or advertisement for DSL's local availability. If so, you know who to contact to get the ball rolling, or at least where to start. In most areas of Northern Arizona that have DSL available, Qwest is the actual owner of the DSLAM. Many of the ISPs simply buy DSL access wholesale from Qwest, and resell the access and services as their own. There are some exceptions, particularly in the business service side of DSL.

MSN, AOL, Mindspring and Earthlink have all announced that they offer DSL services, and coverage is expanding albeit slowly. Many local ISPs are making similar plans. A quick check of your local ISPs' web sites should provide coverage details and plans.

If you don't currently have an ISP, or are looking to change, your next stop would be your local phone company. All of the Regional Bell Operating Companies (RBOCs) like Qwest are all busily rolling out DSL, though coverage in most Northern Arizona communities is still very "spotty."

COMPARING DSL VENDORS

At a high level, DSL Internet service has two components, the DSL connection itself and then associated Internet services like an e-mail address, access to newsgroups and the ability to create your own home page on the world wide web. Typically, both components are provided by a single ISP, though it may be a representative from the local telephone who physically installs the required

equipment. When analyzing or comparing DSL offerings, consider three elements, 1) installation and monthly cost, 2) performance, and 3) feature set.

INSTALLATION COST

Briefly, DSL service requires an DSL modem that connects to your computer (or possibly be installed inside it) via a standard 10- or 100-BASE-T Ethernet network interface card (NIC). Today, even if you know how to install your own network card, you'll need a technician, usually from the phone company, to come out and install a small splitter-filter to your telephone line. In the future, using a technology called G.lite DSL, telephone line modifications may not be necessary, and you'll be able to install all necessary hardware and software yourself. So the first question to ask your service provider is whether they're be installing G.lite or full-rate DSL.

If it's full-rate DSL, there are at least three possible charges, so be sure to ask the following three questions:

- ☐ What is the charge for the necessary hardware, including ADSL modem and network interface card? If you have an NIC installed, ask whether the price will be less.
- ☐ What is the charge for the installation itself? Normally there is a charge for installation since the company will have to send a technician out to your home to install a phone line splitter-filter, the NIC and DSL modem.
- ☐ Is there an initial "service activation fee" for turning on the service? Some DSL service providers charge an activation fee.

HARDWARE NEEDED FOR DSL

You may have the choice to either install the service yourself, or have the service provider come out and install it. If you choose to install the service yourself, ask your service provider to recommend a specific DSL modem and NIC (Network Interface Card), and perhaps even recommended a store or web site to purchase the unit. Of course, if you choose to have the service provider install the NIC and modem, ask about all three charges defined

above. Examples of internal and external DSL modems are shown here.



Figure 5. Examples of Internal and External DSL modems.

For an internal DSL modem, a separate ethernet NIC (e.g., 10/100 BaseT) may not be required.

MONTHLY FEES

When identifying or comparing monthly fees, you have several issues to consider. First, be sure to inquire whether the price is tied to any other phone company service or service group.

Second, ask whether the price includes both DSL connection and Internet service. Most of the time it will, but some companies will quote a monthly fee for the DSL connection, with a selection of ISPs available to provide Internet connectivity for an additional charge.

Next, ask whether pricing, installation or monthly charges, relates to any fixed term commitment. Several DSL providers will waive initial setup fees or reduce monthly charges, but only if you commit to a year or longer term of service.

PERFORMANCE

Finally, several DSL ISPs offer varying DSL connection speeds, some with guaranteed levels of service, some without. For example, you'll pay a smaller monthly fee for a guaranteed 256 Kbps downstream speed and 128 Kbps uplink than you would pay for a guaranteed 1.5 Mbps downstream/384 Kbps upstream connection. However, most ISPs identify maximum download and upload transfer speeds without guaranteeing any level of service. These "bandwidth guarantees" are, however, statistically time averaged by providers, and do *not* certify you will achieve the highest downstream rates at all times. Since DSL is a point

to point connection that we wish would work at top speed all the time, it probably doesn't pay to lose sleep if you can't get guaranteed service levels. Still, connection speeds and guarantees are great features to identify when pricing and comparing potential DSL providers.

FEATURES AND BENEFITS

Those of use who've been on the internet for a while have come to expect a range of services from our ISPs, like e-mail connections, space on their server for FTP and/or personal home web pages and access to newsgroups. So be sure to ask whether these come with your DSL service, and if you have a family, determine the cost for extra server space and additional e-mail addresses. If you need to connect to the Internet from more than one location, ask if there is a telephone dial-up service you can also connect to, if extra charges apply, or if they offer web-based email access. For example, you may want to install DSL at home but connect to the Internet with your laptop from other locations. Most ISPs who offer both DSL and dial-up service won't charge extra for this. If you travel frequently, you should also ask whether 800 service exists to facilitate remote connections. If you want to host a web site at home via ASDL, ask your service provider whether your IP address is static or dynamically assigned (it's almost always dynamic, which means your "public" IP address changes often, making it virtually impossible for the outside world to find your site). Many services explicitly prohibit hosting a web site. Similarly, many services prohibit shared use of the DSL service over a local area network (LAN). For example, Bell Atlantic flatly states "Bell Atlantic will only support one computer to one DSL subscription." For this reason, if you're running a LAN at home, be sure to check your service provider's policies regarding shared access to high-speed access which varies by service provider.

BUSINESS CONSIDERATIONS

Hosting a web site and shared network use are often two critical requirements for small businesses, and these needs have spawned a separate group of service providers that focus specifically on these needs. For example, in Flagstaff Infomagic.Net focuses on consumer DSL, while other service

providers offer more extensive and flexible service for small businesses. Business oriented service providers may offer static IP DSL, which allows you to host a web site via DSL, and doesn't prohibit intra-networking. On the other hand, in addition to higher monthly and installation fees, you may pay for bandwidth consumed in excess of [e.g.] a Gigabyte per month. Still, compared to the high cost of alternatives like T-1, or the relatively slow performance of similarly priced alternatives like dedicated ISDN, the business oriented service provider is a good alternative.

MACHINE REQUIREMENTS

Like any computer peripheral, DSL modems and 10/100 BASE-T ethernet network interface cards, or NICs, have certain minimum computer requirements that need to be met before they can operate. Many DSL service providers place these requirements on their web page, and virtually all query you about your computer before scheduling installation.

SECURITY ISSUES

The recent spate of Denial of Service attacks on popular Web sites like Yahoo!, CNN and Ebay have raised consumers' concerns about Internet security. DSL Forum regularly publishes information on security issues and DSL related solutions since it affects DSL business on a global scale.

DSL offers consumers many benefits such as high-speed connections from 10 to 100 times faster than dial-up, simultaneous voice and data over the same phone line and choice of ISP. DSL also provides consumers with an "always-on" connection, which means consumers can maintain their DSL Internet connections 24 hours a day, seven days a week.

DSL is inherently more secure than other broadband communications, namely cable modem service. DSL is a point-to-point connection between a consumer's home and the telephone company switching office. Cable, on the other hand, is a point-to-multipoint connection that shares network connectivity among homes in a neighborhood, much like a shared LAN. In addition, with DSL each customer has a separate "Private Virtual Circuit," a unique connection that authenticates and secures the

communication between the customer's PC and the Internet.

Despite these obvious advantages of DSL, anybody who establishes a dial-up or "always-on" Internet connection incurs some security risk stemming from the duration of the network connection rather than the access method. A number of standard measures are available that users can apply to protect themselves that we list below for reference:

Turn off file and print sharing in Microsoft Windows™

Set up strong passwords and Virus Scan software

Consider a hardware firewall separate from the PC

Install a software firewall to the PC

Many quality software firewall programs will effectively protect a PC from hacker attack. Several of these programs are free and others charge a nominal fee. For more information, DSL Forum recommends reviewing Gibson Research's Web site at <http://grc.com/x/ne.dll?bh0bkyd2> for information about commercial software firewalls. The site also has a program that quickly checks the security of a computer's connection to Internet. Four common programs are BlackIce Defender at www.networkice.com, ZoneAlarm at <http://www.zonelabs.com/>, Norton Internet 2000 at www.symantec.com and VirusScan or Guard Dog at www.mcafee.com.

In addition, Windows 98™ SE, later versions of NT™ and XP™ has a feature called "Internet Connection Sharing" (ICS) which allows networked PCs in the home to hide behind a central PC and use its IP address. Thus, with NAT potential hackers cannot see networked devices behind the central PC. Also, shared services (file and print) on the PC running ICS are not accessible from the Internet.

OTHER OPTIONS: ENCRYPTION AND VPN (VIRTUAL PRIVATE NETWORK)

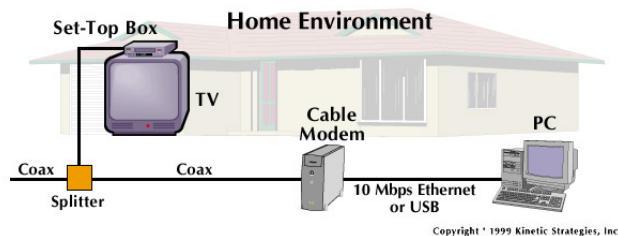
For protected communication with others over the Internet, consider using encryption software, which will securely encode data and decode it at the receiving end. Also, many companies are beginning to use "Virtual Private Networks," hardware and software solutions that enable corporate users to establish secure tunnels between their homes and their corporate LANs -- perfect for telecommuters.

To sum up, a number of effective solutions protect access to the Internet from unwarranted attacks. But DSL has a number of advantages given the nature of the technology and network architectures developed by DSL Forum. The most important note is that the connection between the user and the Internet is "owned" solely by that specific user: it is secure and provides authentication.

DSL Forum will soon release an educational white paper for DSL service providers and consumers about security issues and solutions. Please refer back to DSL Forum's Web site for this paper at http://www.dslforum.org/aboutdsl/security_index.html.

CABLE MODEM OVERVIEW

This Cable Modem tutorial is designed to answer most questions about Cable Modems and the associated technology. The following diagram shows a typical installation scenario.



Assumptions

This presentation deals mainly with what I term 2nd generation Cable Modems. As from the following definition:

1st generation

Proprietary systems. Not based on widely accepted standards. Cable Modems from different vendors does not work on the same CMTS/Head-End. This includes among others the first Com21 systems.

2nd generation

Systems based on standards. MCNS/DOCSIS 1.0/1.1 (US etc.) and DVB/DAVIC 1.3/1.4/1.5 (Europe). Cable Modems from different vendors work together (or can be made work together).

This is the systems that are shipping right now (98/99).

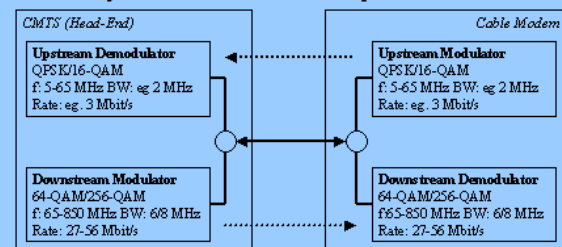
3rd generation

Time will tell. Looks like we will see wireless modems based on the cable modem standards and some more symmetrical cable modem systems also.

Also this presentation deals only with "real" Cable Modems (as in "real men" :-), that does two-way communications on the cable. That excludes the telephone modem return systems, although most of the presentation applies to these systems as well. I do accept that telephone return systems are quite important as a step on the migration path towards "real" Cable Modem systems. But from my (very) technical viewpoint, they are not quite as interesting.

What does Cable Modem mean?

- "CABLE" is short for Cable TV (CATV) Network
- "MODEM" is MODulator-DEModulator
- Actually more like a network adapter than a modem



The term "Cable Modem" is quite new and refers to a modem that operates over the ordinary cable TV network cables. Basically you just connect the Cable Modem to the TV outlet for your cable TV, and the cable TV operator connects a Cable Modem Termination System (CMTS) in his end (the Head-End).

Actually the term "Cable Modem" is a bit misleading, as a Cable Modem works more like a Local Area Network (LAN) interface than as a modem.

OTHER TERMS

A short list of some of the other technical terms and acronyms that you may stumble across in trying to understand the cable modem world.

CATV: Community Antenna Television or Cable TV system. Can be all coaxial or HFC (Hybrid Fiber Coax) based.

Cable modem (CM): Client device for providing data over a cable TV network. Read all about it [here](#).

Channel: A specific frequency and bandwidth combination. Used in this context about TV channels for television services and downstream data for cable modems.

CMTS: Cable Modem Termination System. Central device for connecting the cable TV network to a data network like the internet. Normally placed in the headend of the cable TV system.

CPE: Customer Premises Equipment. Used to describe the PC and/or other equipment, that the customer may want to connect to the cable modem.

DHCP: Dynamic Host Configuration Protocol. This protocol provides a mechanism for allocating IP addresses dynamically so that addresses can be reused. Often used for managing the IP addresses of all the cable modems in a cable plant and the PC's connected to the cable modems.

DOCSIS: Data Over Cable Service Interface Specification. The dominating cable modem standard. Defines technical specifications for both cable modem and CMTS.

Downstream: The data flowing from the CMTS to the cable modem.

Downstream frequency: The frequency used for transmitting data from the CMTS to the cable modem. Normally in the 42/65-850 MHz range depending on the actual cable plant capabilities.

Headend: Central distribution point for a CATV system. Video signals are received here from satellites and maybe other sources, frequency converted to the appropriate channels, combined with locally originated signals, and rebroadcast onto

the HFC plant. The headend is where the CMTS is normally located.

HFC: Hybrid fiber-coaxial (cable network). Older CATV systems were provisioned using only coaxial cable. Modern systems use fiber transport from the headend to an optical node located in the neighborhood to reduce system noise. Coaxial cable runs from the node to the subscriber. The fiber plant is generally a star configuration with all optical node fibers terminating at a headend. The coaxial cable part of the system is generally a trunk-and-branch configuration.

MAC layer: Media Access Control sublayer in the network stack. Read more about that later in this presentation.

MCNS: Multimedia Cable Network System Partners Ltd. The consortium behind the DOCSIS standard for cable modems.

Minislot: Basic timeslot unit used for upstream data bursts in the DOCSIS standard.

MSO: Multiple Service Operator. A cable TV service provider that also provides other services such as data and/or voice telephony.

QAM: Quadrature Amplitude Modulation. A method of modulating digital signals using both amplitude and phase coding. Used for downstream and can be used for upstream.

QPSK: Quadrature Phase-Shift Keying. A method of modulating digital signals using four phase states to code two digital bits per phase shift.

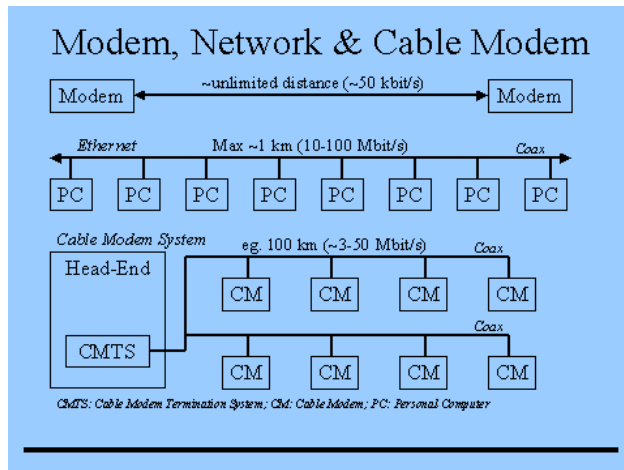
Ranging: The process of automatically adjusting transmit levels and time offsets of individual modems, in order to make sure the bursts coming from different modems line up in the right timeslots and are received at the same power level at the CMTS.

SID (Service ID): Used in the DOCSIS standard to defines a particular mapping between a cable modem (CM) and the CMTS. The SID is used for the purpose of upstream bandwidth allocation and class-of-service management.

Subscriber Unit (SU): An alternate term for cable modem.

Upstream: The data flowing from the CM to the CMTS.

Upstream frequency: The frequency used to transmit data from the CM to the CMTS. Normally in the 5-42 MHz range for US systems and 5-65 MHz for European systems.



Modem

A modem connection is about 50 Kbps, and is used point-to-point. The distance is virtually unlimited, including multiple satellite hops etc.

Ethernet

An ethernet (LAN) connection is 10 Mbps or 100 Mbps, and is used to connect many computers that can all "talk" directly to each other. Normally they will all talk with a few servers and printers, but the network is all-to-all. The distance is normally limited to below 1 km.

Cable Modem

A Cable Modem connection is something in-between. The speed is typically 3-50 Mbps and the distance can be 100 km or even more. The Cable Modem Termination System (CMTS) can talk to all the Cable Modems (CM's), but the Cable Modems can only talk to the CMTS. If two Cable Modems need to talk to each other, the CMTS will have to relay the messages.

The OSI layer software stack for a DOCSIS Cable Modem looks like this. For further explanation of the various acronyms please see the other sections of this tutorial or refer to www.whatis.com (lots of

short concise explanations of especially the network terms).

OSI		DOCSIS	
Higher Layers		Applications	DOCSIS Control Messages
Transport Layer		TCP/UDP	
Network Layer		IP	
Data Link Layer	Link	IEEE 802.2	
Physical Layer		Upstream	Downstream
		TDMA (mini-slots) 5 - 42(65) MHz QPSK/16-QAM	TDM (MPEG) 42(65) - 850 MHz 64/256-QAM ITU-T J.83 Annex B(A)

Items in parenthesis refer to EuroDOCSIS, which is a version of DOCSIS with a modified physical layer targeted at the more DVB centric European market. External box cable modems with ethernet interface normally acts as either MAC-layer bridges (low-end models) or as routers (high-end SOHO models).

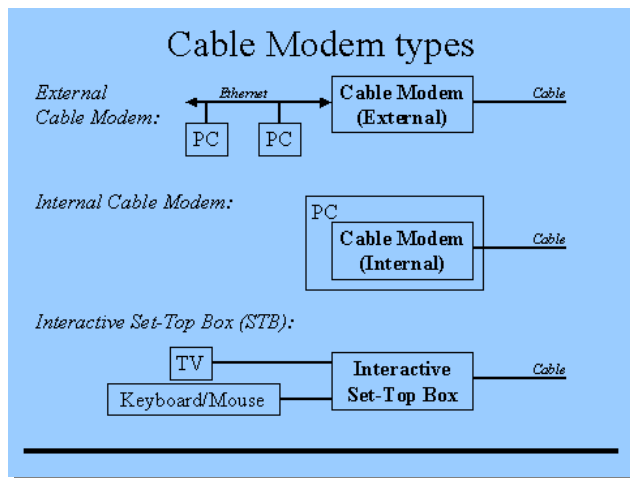
What's a CATV network?

- Used for TV distribution
- Upgrade to allow return channel signals
- Head-End sends out signals
- HFC means Hybrid Fibre-Coax
- Structure is "tree-like"
- The (single) Head-End is the root
- The (many) Cable Modems are at the leaves
- One Head-End to eg. 1000 Cable Modems

A CATV network is designed and used for cable TV distribution. With an upgrade of the system, it is normally possible to allow signals to flow in both directions. Higher frequencies flow toward the subscriber (you?) and the lower frequencies go in

the other direction. This is done by upgrades to the amplifiers in the cable distribution network etc.

Most CATV networks are Hybrid Fiber-Coax (HFC) networks. The signals run in fiber-optical cables from the Head-End center to locations near the subscriber. At that point the signal is converted to coaxial cables that run to the subscriber premises. One CMTS will normally drive about 1-2000 simultaneous Cable Modem users on a single TV channel. If more Cable Modems are required, the number of TV channels is increased by adding more channels to the CMTS.



A number of different Cable Modem configurations are possible. These three configurations are the main products we see now. Over time more systems will arrive.

External Cable Modem

The external Cable Modem is the small external box that connects to your computer normally through an ordinary Ethernet connection. The downside is that you need to add a (cheap) Ethernet card to your computer before you can connect the Cable Modem. A plus is that you can connect more computers to the Ethernet. Also the Cable Modem works with most operating systems and hardware platforms, including Mac, UNIX, laptop computers etc.

Another interface for external Cable Modems is USB, which has the advantage of installing much faster (something that matters, because the cable operators are normally sending technicians out to install each and every Cable Modem). The

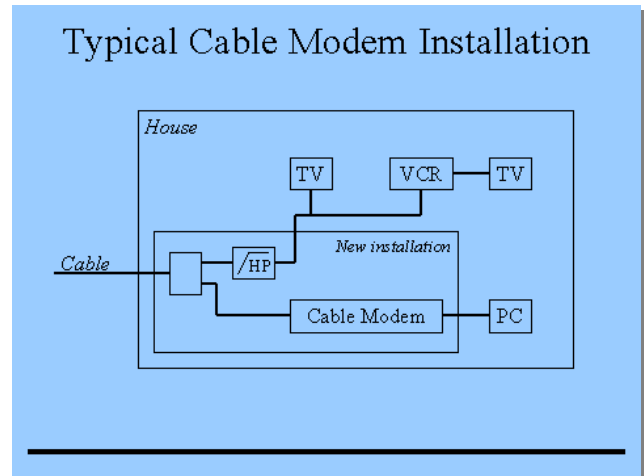
downside is that you can only connect one PC to a USB based Cable Modem.

Internal Cable Modem

The internal Cable Modem is typically a PCI bus add-in card for a PC. That might be the cheapest implementation possible, but it has a number of drawbacks. First problem is that it can only be used in desktop PC's. Mac's and laptops are possible, but require a different design. Second problem is that the cable connector is not galvanic isolated from AC mains. This may pose a problem in some CATV networks, requiring a more expensive upgrade of the network installations. Some countries and/or CATV networks may not be able to use internal cable modems at all for technical and/or regulatory reasons.

Interactive Set-Top Box

The interactive set-top box is really a cable modem in disguise. The primary function of the set-top box is to provide more TV channels on the same limited number of frequencies. This is possible with the use of digital television encoding (DVB). An interactive set-top box provides a return channel - often through the ordinary plain old telephone system (POTS) - that allows the user access to web-browsing, email etc. directly on the TV screen.



When installing a Cable Modem, a power splitter and a new cable is usually required. The splitter divides the signal for the "old" installations and the new segment that connects the Cable Modem. No TV-sets are accepted on the new string that goes to the Cable Modem.

The transmitted signal from the Cable Modem can be so strong, that any TV sets connected on the same string might be disturbed. The isolation of the splitter may not be sufficient, so an extra high-pass filter can be needed in the string that goes to the TV-sets. The high-pass filter allows only the TV-channel frequencies to pass, and blocks the upstream frequency band. The other reason for the filter is to block ingress in the low upstream frequency range from the in-house wiring. Noise injected at each individual residence accumulates in the upstream path towards the head-end, so it is essential to keep it at a minimum at every single residence that needs Cable Modem service.

Data-interface

On any kind of external cable modem (the majority of what is in use today), you obviously need some kind of data-interface to connect the computer and the cable modem.

Ethernet

On most external modems, the data-port interface is 10 Mbps Ethernet. Some might argue that you need 100 Mbps Ethernet to keep up with the max. 27-56 Mbps downstream capability of a cable modem, but this is not true. Even in a very good installation, a cable modem can not keep up with a 10 Mbps Ethernet, as the downstream is shared by many users.

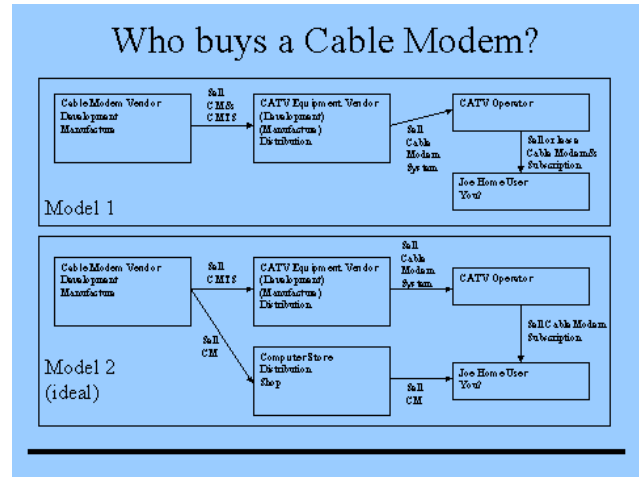
The 1st version of the MCNS standard, that dominates the US market, specified 10 Mbps Ethernet as the only allowable data-interface. The DVB/DAVIC standard is totally open, allowing any type of interface. Other types of interfaces are being incorporated in the MCSN standard to allow for a wider range of cable modem configurations.

USB (Universal Serial Bus)

Among others, Intel recently announced that they are working with Broadcom on cable modems with USB interface. This is expected to bring down the installation hassle for the many users with less computer skills. Obviously you do not need to open the box to install an Ethernet card, if the computer has an USB interface. If the computer does not have an USB interface, you will need to install that (and you are back to about the same hassle-level as with the Ethernet interface).

Cost

The installation cost is a significant issue, as this is something that needs to be done in the house of every subscriber. The CATV operators and equipment manufacturers need to try really hard to push down the installation cost, to keep the whole operation profitable.



Basically Cable Modems are for ordinary people, just like analog modems and ISDN. Two different models exist for the actual buy/sell situations. In both cases the CATV operator sells the Cable Modem access subscription, and takes the role as Internet Service Provider (ISP).

Model 1

The 1st model is what we see now. The Cable Modem vendor normally provides both CMTS and Cable Modem for the system integrator (here called CATV vendor, but this could even be a division of the cable operator). The system integrator provides a complete Cable Modem system to the cable operator. This might include the necessary return channel amplifiers etc. The subscriber leases (or buys) the Cable Modem from the CATV operator, much like the model normally used for set-top boxes.

Model 2

The 2nd model is the ideal model from many viewpoints, but can not be implemented before the Cable Modem standards are firm enough to guarantee Cable Modems from various vendors to work smoothly together on the same Cable Modem system. The difference here is that the subscriber buys the Cable Modem in a computer store as he

would buy any other modem. The CATV operator only provides the Cable Modem service.

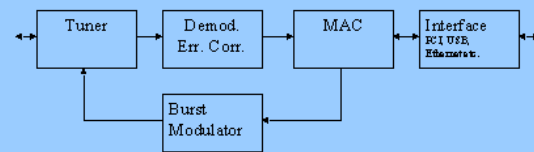
Cable modems for sale in the retail stores is actually a reality now, in some areas of the US (start of 1999). That simply proves that it can be done, but from what I can tell, the lease-model (model 1) is still by far the most common approach.

CM Vendors

For DOCSIS modems, the following is an (probably soon incomplete) list of vendors with actual DOCSIS certified products (accurate august 1999):

- Toshiba
- Thomson Consumer Electronics
- 3Com
- General Instrument
- Arris Interactive
- Askey Computer Corp. (partnering with Cisco for the reference design)
- Cisco Systems
- Philips Electronics (partnering with Cisco for the reference design)
- Samsung Information Systems of America (partnering with Cisco for the design)
- Sony Corp (partnering with Cisco for the reference design)
- Other companies are known to have cable modems that are either proprietary or conforming to other standards like DVB/DAVIC:
- COM21 (Proprietary ATM based system. Also shipping DOCSIS modem).
- Zenith (Proprietary system)
- LanCity/Bay Network (Proprietary system)
- NetGame (Proprietary system, working on DOCSIS system also)
- COCOM (DVB-RCC/DAVIC based system)
- DeltaKabel (Proprietary system. Also a EuroDOCSIS based system).

What's inside a Cable Modem?



- Tuner converts TV channel to a fixed lower frequency (6-40 MHz)
- Demodulator performs A/D, demodulation, error correction and MPEG synchronization
- MAC extracts data from MPEG frames, filters data for other Cable Modems, runs the protocol, times transmission of upstream bursts etc.
- Burst modulator performs R-S encoding, modulation, frequency conversion, D/A conversion etc.
- Interface can be PCI bus, Universal Serial Bus, Ethernet or other?

Cable Modems are different, but the basic architecture is more or less the same as shown above. The major components are outlined below, along with an indication of some companies that are known to deliver products to the open market. Many other companies are working in the field, but may not be so well known to me - or may only produce components for their own use.

Tuner

The tuner connects directly to the CATV outlet. Normally a tuner with build-in diplexer is used, to provide both upstream and downstream signals through the same tuner. The tuner must be of sufficiently good quality to be able to receive the digitally modulated QAM signals. Companies like ALPS, Sharp, Temic and Panasonic are strong suppliers here.

A new concept of a silicon tuner is in the works. This is basically a tuner on a chip, and is expected to cut the cost down quite a bit compared to a more conventional tuner module.

Demodulator

In the receive direction, the IF signal feeds a demodulator. The demodulator normally consists of A/D converter, QAM-64/256 demodulator, MPEG frame synchronization, Reed Solomon error correction.

The clear leader here is Broadcom, with a single chip demodulator. Other companies are Stanford Telecom with a combined demodulator and burst modulator, but also companies like SGS Thomson, VLSI Technologies, LSI Logic and Fujitsu play a

role here. The demodulator component is required both in a cable modem and in the more mature product, the digital (receive-only) set-top box, so many companies have developed products for this part of the game.

Burst Modulator

In the transmit direction, a burst modulator feeds the tuner. The burst modulator does Reed Solomon encoding of each burst, modulation of the QPSK/QAM-16 on the selected frequency and D/A conversion. The output signal is feed though a driver with variable output level, so the signal level can be adjusted to compensate for the unknown cable loss.

The burst modulator is unique to the cable modem (and some two-way set-top boxes), so less component are available here. Broadcom leads the pack, with Stanford Telecom, Analog Devices, SGS Thomson and others playing catch-up.

Combined demodulator and burst modulator chips are also available as the integration race drives more and more functions into a single chip.

MAC

A Media Access Control mechanism sits between the receive and transmit paths. This can be implemented in hardware or split between hardware and software. The MAC is pretty complex compared to an ethernet MAC, and in reality no MAC's are able to handle all of the MAC layer function without some microprocessor "help".

For DOCSIS cable modems, Broadcom and Libit (now Texas Instruments) are known to have MAC ASIC's available as a standard products Connexant is also in the market with a MAC that rely more on software to handle the various functions, supposedly giving more flexibility. Other companies are known to be working on various MAC chips for both DOCSIS and DVB/DAVIC, with different partitions of what goes in software and hardware. Some cable modem manufacturers even develop their own MAC apparently in an attempt to be more competitive or to differentiate their products.

Interface

The data that pass through the MAC goes into the computer interface of the Cable Modem, be it Ethernet, USB, PCI bus or whatever.

CPU

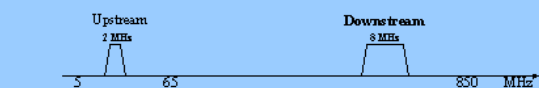
The microprocessor is not explicitly shown on the diagram, but for external cable modems a CPU is required. Some work is being done on host based processing cable modems, that uses the processor in the host (PC or Mac) to do all (or almost all) processing. Much like how analog telephony modems (WinModem) rely on the PC processor to do the processing.

For external cable modems with Ethernet interface, the Motorola embedded PowerPC series of microprocessors are popular, but other RISC based architectures are also used.

Single devices combining MAC, demodulator, burst modulator, processor, ethernet/PCI/USB interfaces and more are emerging, in effect integration the guts of a cable modem in a single chip. There will still be some additional parts for memory, tuner, analog stuff, power supply etc. so we are still no-where near the true single-chip cable modem - even though that is what the marketing guys tout.

What is Downstream?

- What the Cable Modem receives
- Frequency 65-850 MHz
- Bandwith 6 MHz (USA) or 8 MHz (EU)
- Modulation 64-QAM (or 256-QAM)
- Data-rate 27-56 Mbit/s (4-7 Mbyte/s)
- Continous stream of data
- Received by all modems



Downstream is the term used for the signal received by the Cable Modem. The electrical characteristics are outlined in the below table. Notice that most CATV networks in Europe allows 8 MHz bandwidth TV channels, whereas the US CATV networks allows only 6 MHz. Again Europe runs a little faster...

Frequency	42-850 MHz in USA and 65-850 MHz in Europe
Bandwidth	6 MHz in USA and 8 MHz in Europe
Modulation	64-QAM with 6 bits per symbol (normal) 256-QAM with 8 bits per symbol (faster, but more sensitive to noise)

The raw data-rate depends on the modulation and bandwidth as shown below:

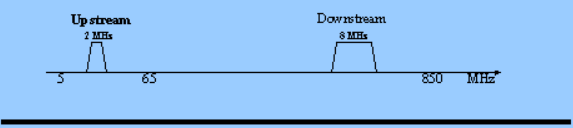
	64-QAM	256-QAM
6 MHz	31.2 Mbit/s	41.6 Mbit/s
8 MHz	41.4 Mbit/s	55.2 Mbit/s

Note: A symbol rate of 6.9 Msym/s is used for 8 MHz bandwidth and 5.2 Msym/s is used for 6 MHz bandwidth in the above calculations. Raw bit-rate is somewhat higher than the effective data-rate due to error-correction, framing and other overhead.

Since the downstream data are received by all Cable Modems, the total bandwidth is shared between all active Cable Modems on the system. This is similar to an Ethernet, only the wasted bandwidth on an Ethernet is much higher. Each Cable Modem filters out the data it needs from the stream of data.

What is Upstream?

- What the Cable Modem transmits
- Frequency 5-65 MHz (5-42 MHz)
- Bandwidth eg. 2 MHz.
- Modulation QPSK or 16-QAM
- Data-rate eg. 3 Mbit/s (~400 KB/s)
- Transmit bursts of data in timeslots (TDM)
- Reserved and contention timeslots



Upstream is the term used for the signal transmitted by the Cable Modem. Upstream is always bursts, so many modems can transmit on the same frequency. The frequency range is typically 5-65 MHz or 5-42 MHz. The bandwidth per channel may be e.g. 2 MHz for a 3 MBit/s QPSK channel.

The modulation forms are QPSK (2 bits per symbol) and 16-QAM (4 bits per symbol), with the later

being the fastest, but also most sensitive to ingress. One downstream is normally paired with a number of upstream channels to achieve the balance in data bandwidths required.

Each modem transmits bursts in time slots, that might be either marked as reserved, contention or ranging.

Reserved slots

A reserved slot is a time slot that is reserved to a particular Cable Modem. No other Cable Modem is allowed to transmit in that time slot. The CMTS (Head-End) allocates the time slots to the various Cable Modems through a bandwidth allocation algorithm (notice: this algorithm is vendor specific, and may differentiate vendors considerably). Reserved slots are normally used for longer data transmissions.

Contention slots

Time slots marked as contention slots are open for all Cable Modems to transmit in. If two Cable Modems decide to transmit in the same time slot, the packets collide and the data is lost. The CMTS (Head-End) will then signal that no data was received, to make the Cable Modems try again at some other (random) time.

Contention slots are normally used for very short data transmissions (such as a request for a number of reserved slots to transmit more data in).

Ranging slots

Due to the physical distance between the CMTS (Head-End) and the Cable Modem, the time delay

vary quite a lot and can be in the milliseconds range. To compensate for this all Cable Modems employ a ranging protocol, that effectively moves the "clock" of the individual Cable Modem forth or back to compensate for the delay.

To do this a number (normally 3) of consecutive time-slots are set aside for ranging every now and then. The Cable Modem is commanded to try transmitting in the 2nd time-slot. The CMTS (Head-End) measures this, and tells the Cable Modem a small positive or negative correction value for its local clock. The two time slots before and after are the "gap" required to insure that the ranging burst does not collide with other traffic.

The other purpose of the ranging is to make all Cable Modems transmit at a power level that makes all upstream bursts from all Cable Modems arrive at the CMTS at the same level. This is essential for detecting collisions, but also required for optimum performance of the upstream demodulator in the CMTS. The variation in attenuation from the Cable Modem to the CMTS can vary more than 15dB.

Downstream data format

MPEG Payload	FEC Byte	MPEG Header	MPEG Payload	FEC Byte
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- Reed-Solomon error correction
- Corrects 6 errors in 204 bytes
- MPEG-TS (Transport Stream)
- MPEG-PS (Program Stream)
- MAC messages
- ATM cells (DVB/DAVIC)
- Data addressed to one, many or all Cable Modems

Downstream data is framed according to the MPEG-TS (transport stream) specification. This is a simple 188/204 byte block format with a single fixed sync byte in front of each block. The Reed-Solomon error correction algorithm reduces the block size from 204 bytes to 188 bytes, leaving 187 for MPEG header and payload.

This is where the various standards differ quite a lot. Some standards even allow various formatting of data within the MPEG-TS payload.

For the DVB/DAVIC standard, the framing inside the MPEG-TS payload is simply a stream of ATM cells.

Upstream data format

ATM Payload	Gap	UW 1 bit	ATM Header	ATM Payload	Gap	UW 1 bit
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- Reed-Solomon error correction
- Prepend unique word
- One ATM cell per burst (DVB/DAVIC)
- MAC message or data as payload
- 18 time-slots per 3 ms (DVB/DAVIC)
- Reserved time-slots for longer data
- Contention time-slot for small data (initiate)
- Ranging time-slots are 3 slots

Upstream data is arranged in short bursts. The DAVIC/DVB standard requires a fixed length burst, whereas the MCNS standard specifies variable length bursts.

Since the upstream data is just a short burst of data, the demodulator needs something to trigger on. That is the unique word, that is pre-pended to the data. For DVB/DAVIC the unique word is 32 bit of data that triggers the demodulator to demodulate the burst.

Without the unique word, the demodulator could easily start to demodulate various noise signals etc. And then be all busy doing that when the real data arrives. Also the unique word provides re-synchronization at every burst.

What is MAC?

- Media Access Control
- Implemented in HW and maybe some SW
- Performs ranging to calibrate TX level
- Performs ranging to calibrate time reference
- Assigns upstream frequency and data-rate
- Allocates time-slots (upstream bandwidth)
- Runs on both Cable Modem and Head-End
- Very similar to satellite protocol

The Media Access Control mechanism is normally implemented in hardware or in a combination of hardware and software. The primary purpose of the MAC is to share the media in a reasonable way. Both the CMTS and the Cable Modem implements protocols to do:

- Ranging to compensate for different cable losses. It is essential that the upstream bursts from all Cable Modems are received in the Head-End at the same level. If two Cable Modems transmit at the same time, but one is much weaker than the other one, the CMTS will only hear the strong signal and assume everything is okay. If the two signals are same strength, the signal will garble and the CMTS will know a collision occurred.
- Ranging to compensate for the different cable delays. The size of a CATV network calls for fairly large delays in the millisecond range.
- Assigns frequencies etc. to the Cable Modems. The Cable Modem first listens to the downstream to collect information about where and how to answer. Then it signs on to the system using the assigned upstream frequency etc.
- Allocate the time-slots for the upstream.
- It is impossible to give more detailed information about the MAC, without going into the specific standards. This is one of the areas that are most closely tied to the specific standard.

What standards?

- Proprietary systems (1st generation systems).
- MCNS (USA mainly). Developed for Cable Modem only. Specifies external Cable Modem only, but may add internal Cable Modem also.
- DAVIC/DVB (Europe mainly). Used for set-top box and now also Cable Modem.
- IEEE 802.14 lost 1st round, but tries to leapfrog and be the standard of the future (3rd generation systems).

Three major standards exist for Cable Modems! First generation Cable Modems uses various proprietary protocols etc. making it impossible for

the CATV network operators to use multiple vendors Cable Modems on the same system.

Around 1997 three standards emerged. DAVIC/DVB were first with a European standard, closely followed by MCNS with a US standard (DOCSIS). IEEE came last with 802.14, and clearly lost the 1st round. IEEE is now trying to leap-frog the two other standards by focusing on the next generation standards.

DVB/DAVIC

This standard is also known as DVB-RCC and as ETS 300 800. Initially run by DAVIC, but now the work has moved to DVB. Very few vendors develop for this standard, but enough that it does play a role. This standard is fighting the EuroDOCSIS standard for the European market (see below).

This standard is based on fixed cell size (ATM) and includes all the standard ways of doing quality of service (QoS) that ATM is known for. In that way, the standard is very well suited to both data i.e. TCP/IP (using AAL5) and telephony as pure ATM. VoIP to the cable modem may not be the best solution, although technically feasible.

Initially the standard lacked security (encryption), but that was added as an option in version 1.4.

Open to both internal and external implementations, and also covering Set-Top Box implementations with an additional out-of-band receive data channel. Some of the European cable operators joined forces and made a request for proposals for a EuroModem. The specification is available to the public from EuroCableLabs for free, and even though it does not seem very big, it does refer to other standards including ETS 300 800 for the details. A PDF of the specification is available [here](#).

MCNS/DOCSIS

The dominant US standard - even though it has not gone through any formal/independent standards body yet. This standard is very much driven by the wish of the large cable operators to have cable modems sold through the retail channel. Initially the chip manufacturer Broadcom played an important role, by pushing the standard and the level of chip integration at a very fast pace. As a result, the

complexity of the standard is generally agreed to be much higher than what is strictly required, and is even growing.

Initially the standard did not support QoS which is required for telephony applications (VoIP) and other applications as well, but this has been added in version 1.1.

Initially open to only external box solutions with Ethernet interface, but now also allows internal modems and USB modems. Host based processing solutions is still debated (start 1999).

While originally targeted at the US domestic market, an off-spring named EuroDOCSIS is being pushed as the solution to the DVB centric European market. EuroDOCSIS is essentially the same as DOCSIS apart from the physical layer, which is DVB compliant in EuroDOCSIS.

IEEE

Lost the 1st round of the Cable Modem standards battle. What happens down the road remains to be seen. It looks like part of the IEEE group is working with Broadcom and Terayon on the next generation physical layer with increased (30 Mbps) upstream bitrate. This has also been termed DOCSIS 1.2, even though that does not seem to be official, and is certainly not approved by the DOCSIS vendor community yet.

The battle for the US domestic market is clearly won by the DOCSIS standard, but the battle for the European market is still going on. It does not seem like at very fair match, but nevertheless quite interesting. The following somewhat biased "whitepapers" are among the most visible parts of the fight.

October 1998: Gregers Kronborg who is Chairman DVB/DAVIC Interoperability Consortium but also co-founder of DVB cable modem manufacturer COCOM writes this: Comparing DVB RCC / DAVIC with OpenCable MCNS (PDF file - also available on the DVB website www.dvb.org).

May 1999: Tom Quigley from Broadcom Corporation presents his "whitepaper" EuroDOCSIS/DVB-RC Comparison (PDF file - also available on the CableLabs website www.cablemodem.com) on a EuroDOCSIS

promotion tour of some European countries (Stockholm, Vienna, Paris, Zeist and London).

May 1999: Henry Barton who is MD for Broadcentric Ltd. publishes another similar but much more detailed "whitepaper" titled DOCSIS MCNS vs. DVB/DAVIC DVB-RCC - The Case For DOCSIS in Europe: A Cable Operator & Industry Perspective (PDF file) to complement the above Broadcom presentation.

Why is this so cool?

Speed, speed and speed	On-line full-time
<ul style="list-style-type: none">• Analog modem speed x100 to x1000• ISDN speed x25 to x500• Comparable to T1/E1 or better (~2 Mbit/s)• Surf while you listen to high quality Real Audio	<ul style="list-style-type: none">• Who wants to be a part-time geek, when you can be full-time?• No dial-up• Get e-mail instantly• Run your own web-server• Game when you want

Is this cool or what?

So what will the cable modem give you, that you don't already have with your analog or ISDN modem connection?

Speed

Cable Modems are much faster. Speeds from x25 to x1000 are possible today, and we are now only at the beginning of the Cable Modem era! Remember 1200 baud analog modems?

Compare the speed you get to that of E1/T1 or ethernet. Notice: This is the speed from you to the CATV operator (ISP). Provided he do not sell too many Cable Modems in your area and/or upgrade his equipment to keep up with the number of Cable Modems.

To provide high speed access to other sites the internet, the CATV operator also needs fairly large proxy cache servers and a very fast connection to the net. We will see the CATV operators put a lot of (local) content, to which you will have very fast access.

On-Line

Cable Modems are on-line whenever you turn on your computer. Just like the network (LAN) used in most offices etc.

This allows a whole new range of applications - just start to think about it.

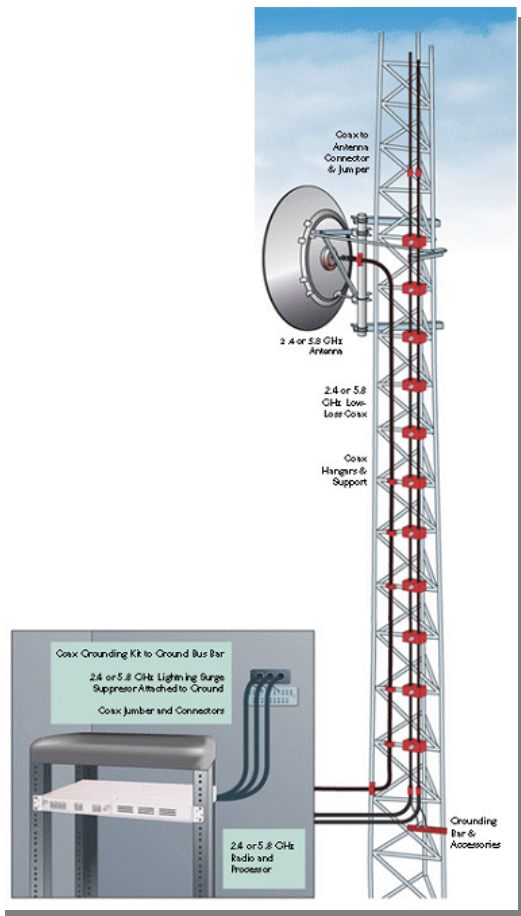
Some cable operators do not like you to run web servers or FTP servers through your Cable Modem,

but that may change over time when they realize that they are selling bandwidth.

Competition

Cable companies in many areas will make significant headway in competing against telephone companies once cable systems are upgraded to telephony-capable subsystems (DOCSIS 2.0 compliant). For rural Arizona, however, it will likely be between 3 and 10 years before that happens.

FIXED WIRELESS AND SATELLITE OVERVIEW



FIXED WIRELESS

Fixed wireless, more commonly known as “microwave” circuits have been in existence for many years. Using highly directive antennas, microwave circuits have served as a simple and relatively cost-effective way to establish point-to-point, high bandwidth paths that could side-step the time and cost issues associated with laying dense copper or fiber. While early microwave circuits employed analog technology, newer ones are digital. With advanced modulation techniques, these new systems are able to achieve 3-5 times the data throughput than their analog predecessors - and typically operate at T1 or multiple T1 (1.5 Mbps), DS-3 (~45 Mbps) or even OC-3 (155 Mbps) rates. The advantage of fixed wireless for establishing high-speed connectivity are:

- Reach from [e.g.,] few miles to over 30 miles without repeaters
- Can use licensed or unlicensed bands, and is generally secure because of its point-to-point directivity
- Equipment costs typically in the \$6K to \$30K range (per end)

There are also some disadvantages (or at least compromises) to consider:

- Atmospheric conditions (weather) may cause significant signal degradation or even outage, especially in heavy rainfall
- The RF spectrum is limited and subject to interference by other wireless operators; in many cases a license may be required to operate.
- Adding redundancy can increase cost significantly to meet reliability needs.

Many variations of fixed wireless equipment exist, and there are many equipment vendors. Equipments are available for the FCC-approved bands (licensed and unlicensed), which vary from approximately 900 MHz to over 40 GHz. Many employ frequency-hopping and spread-spectrum techniques that allow frequency reuse by other operators with little if any interference.

SATELLITE

KA BAND SATELLITES

Six major corporations, including Hughes Communications, Loral Aerospace, Panamsat, GE Americom, and Motorola in conjunction with Microsoft are engaged in the development of five competing Ka Band satellite services that may be deployed in the next few years.

It is customary to refer to the frequencies used by satellites with two figures, such as 20/30 gigahertz (GHz) Ka Band. The first figure is the frequency of the downlink and the second, the uplink. The FCC opens new frequency bands to provide greater capacities, enable provisioning of future services, and account for saturation of existing spectrum allocations. The three major thrusts have been from 4/6 GHz C Band, which use large dishes popular in the eighties, to 12/14 GHz Ku Band, which, like

DirecTV use 18" dishes, to 20/30 Ka Band. (The decreasing dish size is not related to the frequency allocation, but a result of newer satellites deploying higher power transmitters than before; the dish size needed to capture the signal is inversely proportional to the power of the transmitted signal.)

The Ka Band is now being deployed for the first time in commercial satellite applications. The promise of these new satellites is that they offer global coverage for two-way broadband data services at very high transmission speeds--up to 64 Mbps downlink and 2 Mbps uplink--without wires, cables or truck rolls. Their competitive impact remains subject to speculation. They will obviously impact the global business applications market, as they represent the next generation for services using very small aperture terminals. One can speculate on residential penetration, but at least two companies already have inroads with consumers. Hughes owns DirecTV that serves millions of homes with Ku Band service. By the time their Ka Band network is operational, they will have even more customers. Hughes has announced plans for DirecTV to market its new Ka Band services under the name Spaceway. Microsoft and Motorola are partnering to offer Ka Band service under the name Teledesic which is billed as the "Internet in the Sky." What these companies eventually charge for their services will determine how rapidly they will compete with ground based systems. If they are able to provide competitively priced services, they may gain market share as rapidly as, or more rapidly than, DirecTV has done in the last few years. If so, this could be especially beneficial to rural Vermonters, as a means for obtaining broadband services.

NEXT GENERATION ANTENNAS

New transmission technologies can affect the deployment of wireless antennas and towers. For example, dual 45 slant polarization antennas, available since 1997, reduce the total number of antennas necessary for coverage of a cellular telephone sector. A single tower or building top antenna location previously required three sets of three antennas, each set covering a 120 degree sector. Fewer antennas are less obtrusive and easier to camouflage.

These new antennas are more economical, can provide same capacity and equal coverage within a cell site for less cost, and therefore should be an attractive market driven solution for wireless network service providers. Although not applicable in all situations (i.e. highway coverage), these antennas will still provide an answer for the majority of situations providers are faced with, especially in urban and dense urban areas. Currently a large portion of the 1900 MHZ networks built in the U.S. is already deploying dual polarization antennas. The 800 MHZ networks deployed in the new digital CDMA technology are considering using this technology as well, since the FCC considers CDMA an alternate technology and allows transmission on a dual slant polarization antenna, while in the past transmission in a cellular network could only be done using a vertical linear polarized antenna.

Another class of next generation antennas is "smart antennas." Beginning to come to the marketplace, they can provide increased functionality, for example to fix the location of a mobile transmitter, as required for wireless E 9-1-1 service. They are electronically steered and can focus on a mobile vehicle regardless of its position, and are able to follow the user.⁴⁷

In summary, these new antennas should be an attractive option for new mobile telephone service providers, companies extending their networks, or companies making the transition from an analog to a digital service network. This should reduce the total number of antennas necessary for coverage in any cell sector, and those antenna sites should therefore be less conspicuous as well. This does not, however, impact the placement of other (TV, radio or wireless communications) antennas on transmission towers broadcasting their omnidirectional signals from the tops of mountains.

⁴⁷From conversations with Cyril Berg, Huber Suhner Wireless Systems VP, 1998. (Huber Suhner is a Swiss company with its U.S. base in Essex, Vermont. It is a major player in the worldwide market for supplying components to original equipment manufacturers and telecommunications service providers, such as Ericsson, Lucent, Motorola, Alltel, and other companies that build cable and wireless networks.) Also, from conversations with radio engineer Mark F. Hutchins, President of Broadcast Services Inc., of Brattleboro, Vermont, 1998.

WIRELESS TECHNOLOGY OVERVIEW

For the purposes of this overview, the wireless technology intended for discussion specifically focuses on IEEE 802.11 versions of wireless - also referred to as “Wi-Fi” or Wireless LAN (WLAN) technology. These systems are most frequently operated in the point-to-multipoint configuration - with the expressed intent of allowing multiple users access the wireless broadband bandwidth as either “free access” to the network - at least to a defined amount of bandwidth, or as a member of a “private” network if configured as such.

THE THREE MOST NOTABLE 802.11 VARIANTS ARE (CHRONOLOGICALLY):

802.11b: The original Wi-Fi network devices were of this variant. They provide a wireless connection rated at up to 11 Mbps dependent on range. Since these devices operate at very low power levels, range is limited to around 300 meters, and can be significantly affected by obstructions. However, it works very well within the confines of most homes, performing typically between 5 and 10 Mbps. There are even proprietary versions of 802.11b equipment that can operate at speeds up to 22 Mbps, but are not compatible with link standards in that mode. Devices in this category have come down in price substantially since their introduction a year and a half or so ago. PC cards like those shown below can be obtained in some cases for less than \$50. The wireless hub/router - which incorporates also traditional 10/100 BaseT ports and firewall software have dropped recently to less than \$100 during sales.



802.11b PCI network card.



802.11b PC Card



802.11b Wireless Hub/Router

802.11a: The follow-on to its predecessor, 802.11a added substantial connection speed to the growing list of wireless options....however, equipment from the two variants are not compatible in any direct way. 802.11a is designed to operate at speeds up to 52 Mbps, but at ranges substantially less than 802.11b for example (802.11a is designed to operate at 52 Mbps at ranges of up to 100 meters, and degrades rapidly away from the 52 Mbps achievable rate as range increases. The devices look surprisingly similar to the 802.11b devices shown above, but the RF modulations (coded orthogonal frequency division multiplex - COFDM) make the two standards not interoperable.

802.11g: The logical follow-on to 802.11a, the “g” variant allows data transmission speeds up to 54Mbit/s while remaining 100% backward compatible with the existing installed base of over 30 million Wi-Fi or 802.11b systems worldwide. Designed to support the new 802.11g high-rate draft standard for wireless local area networking (WLAN) products operating in the 2.4GHz band, some of the newest chipsets provide twice the range and consequently higher throughput than currently marketed 802.11a WLAN products and over three times the throughput of existing 802.11b products. The very latest have even integrated both 802.11g with chipsets for 802.11a for universal 802.11 support.



EMERGING WIRELESS STANDARDS - WiFi TO THE MAX

IEEE WIRELESS STANDARDS

IEEE 802.11 (Wi-Fi) has taken the world by storm, but the standard has performance as well as security limitations when it supports more than a few users needing guaranteed bandwidth. Often, too, RF interference, perhaps from a competitor's network, can be a significant problem when covering large areas because Wi-Fi operates in unlicensed regions of the radio spectrum. Because no operator is doing anything illegal, there are no non-technical remedies.

A NEW STANDARD TO THE RESCUE

To create standards for broadband wireless access that would be appropriate for longer distances and broader coverage, the IEEE 802 group set up the IEEE 802.16 working group. The first IEEE 802.16 standard, published in April 2002, defines the WirelessMAN Air Interface—the characteristics of the signal sent through the air—for wireless metropolitan-area networks (MANs). These systems are meant to provide network access to homes, small businesses, and commercial buildings as an alternative to traditional wired connections.

A nonprofit consortium of companies known as WiMax (San Jose, Calif.) was created to spur commercial development of 802.16 products by ensuring their interoperability. Access points and cards for PCs and PDAs won't be available until mid-2004 at the earliest.

With wireless base station equipment targeted at under US \$20 000, IEEE 802.16 can economically serve up to 60 customers with high-speed connections of at least 1 Mb/s. In addition, 802.16 can connect 802.11 hotspots to the wired Internet backbone.

HOW 802.16 WORKS

Supporting point-to-multipoint data connections in the 10–66-GHz range, 802.16 transmits at data rates of up to 120 Mb/s. At those frequencies, transmission requires line of sight, and roofs of buildings provide the best mounting locations for

base and subscriber stations. The base station connects to a wired backbone and can transmit wirelessly over up to 50 km to a large number of stationary subscriber stations, possibly hundreds.

To accommodate non-line-of-sight access over lower frequencies, the IEEE published 802.16a in January 2003. IEEE 802.16a operates in licensed and unlicensed frequencies between 2 GHz and 11 GHz, using orthogonal frequency division multiplexing (OFDM), which is similar to 802.11a and 802.11g.

The 802.16 media access control (MAC) layer supports many different physical layer specifications, both licensed and unlicensed (hence, the need for the interoperability organization WiMax). Through the 802.16 MAC, every base station dynamically distributes uplink and downlink bandwidth to subscriber stations using time-division multiple access (TDMA). This is a dramatic difference from the 802.11 MAC, which uses carrier-sensing mechanisms that don't provide effective bandwidth control over the radio link.

Imagine having DSL- or T1-speed communications access for *all* your office locations, not just in office parks or urban centers. Would you like to provide metropolitan area broadband-speed links for all your staff, without leasing expensive circuits or installing costly fiber? As a home user, would you like to have a wireless broadband alternative to DSL and cable modems? The new IEEE 802.16 standard promises to deliver all of this and more.

802.16, the latest entry in the wireless networking technology pantheon, is an up and coming serious contender as a wireless alternative to DSL, cable modem, leased lines, and other broadband network access technologies. Intel has already [pledged](#) to develop a silicon product based on the 802.16 standard, and it claims equipment based on its chips will have a range of up to 30 miles and the ability to transfer data, voice, and video at speeds of up to 70 Mbps.

And while 802.16 products will not be widely available for at least another year or so, the standard

itself should play an important role in your future network plans. 802.16 has the potential to slash your long-haul network/internet access costs and allow you to deploy a broadband mesh connecting all your sites in a region, which could reduce the requirement for leasing circuits or fiber, enable data center consolidation, and generate additional cost savings. With that in mind, it's important to get up to speed with the development of the various 802.16 standards.

BROADBAND WIRELESS ACCESS

The telecommunications companies have made huge capital investments over many years to support POTS (plain old telephone service). In a regulated environment, Ma Bell was assured of a reasonable return on its investment. These days, building the “last mile” of fiber connectivity to an office park or city neighborhood can be highly speculative with an enormous up-front investment required before a carrier can expect to collect any revenue.

In contrast, broadband wireless has the potential to vastly reduce the initial investment and risk. Because customer premises equipment is a significant portion of the cost of wireless deployment, deferring that investment until the carrier signs up the customers can be a great advantage. Like a cell phone network, the carrier would pre-install base station transceivers on towers, poles, church steeples, or other high, fixed platforms. Unlike a cellular network, the customer's transceiver normally is stationary, typically located on a roof — not unlike a satellite dish installation. Because conventional “last mile” connectivity remains so expensive, the idea to use wireless technology instead is hardly new. The FCC auctioned bandwidth for something called Local Multipoint Distribution Service (LMDS) back in 1998 and 1999. The key selling points behind LMDS, 802.16, and related technologies are that they have the potential to be deployed far faster, less expensively, and more flexibly than similar wireline installations.

However, despite the benefits of broadband wireless access, you might have noticed that it is not yet readily available. This can be explained in part by the implosion of the data networking

industry during the economic downturn, but another factor preventing widespread deployment is that until recently there has been no single, well-accepted standard for broadband wireless access. The growing success and popularity of 802.11 has turned the spotlight on 802.16 at just the time when it has passed a number of significant standards milestones.

IEEE 802.16 PROGRESS

Work on 802.16 started in July 1999. Four years into its mission, the IEEE 802.16 Working Group on Broadband Wireless Access has delivered a base and three follow-on standards.

IEEE 802.16 (“Air Interface for Fixed Broadband Wireless Access Systems”) was approved in December 2001. This standard is for wireless MANs operating at frequencies between 10 and 66 GHz.

IEEE 802.16.2, published in 2001, specifies a “recommended practice” to address the operation of multiple, different broadband systems in the 10-66 GHz frequency range.

In January of this 2003, the IEEE approved an amendment called 802.16a, which adds to the original standard operation in licensed and unlicensed frequency bands from 2-11 GHz.

802.16c, which was approved in December 2002, is aimed at improving interoperability by specifying system profiles in the 10-66 GHz range.

Authorization for the development of a new amendment known as 802.16e, which would extend the standard to cover “combined fixed and mobile operation in licensed bands” (2-6 GHz), was approved in December 2002.

OTHER WIRELESS BROADBAND STANDARDS

802.16 is not the only wireless broadband standard in the pipeline, and the IEEE is not the only industry group working on new standards for broadband wireless data services. Parallel to 802.16, the IEEE has also created a new working group, 802.20, which is charged with “the physical

and medium access control layers of an air interface for interoperable mobile broadband wireless access systems that operate in licensed bands below 3.5 GHz.” 802.20’s technical goal is to “optimize IP-based data transport, target peak data rates per user at over 1 Mbit/sec, and support vehicular mobility up to 250 km/hour.”

Meanwhile, the ETSI (the European Telecommunications Standards Institute) project BRAN (Broadband Radio Access Networks) has been creating two standards that are roughly parallel to IEEE 802.16 and 802.16a. HIPERACCESS covers frequencies above 11 GHz. While work on HIPERACCESS began before 802.16, it was approved after 802.16. HIPERMAN is for frequencies below 11 GHz. The two standards bodies cooperate to a certain extent.

Think of the vast opportunities that these new wireless technologies would open for carriers. Service providers could offer broadband wireless data connectivity as ubiquitous as cell phone connectivity, without the need to co-market hotspots. They could even extend it to moving targets like cars, RVs, and trains.

Which technology will providers adopt for the future? Could 802.16 and PDAs eventually replace cellular technology and handsets for wireless telephone service? The answers will depend on many factors, including which standard is translated into readily available products first as well as continuing advances in battery technology.

IMPORTANCE OF FREQUENCY BANDS

Compared with LMDS, 802.16 is a next-generation technology that operates over greater distances, provides more bandwidth, takes advantage of a broader range of frequencies, and supports a greater variety of deployment architectures, including non-line-of-sight operation — a very significant advantage. 802.16 is nominally specified to operate over a 50 km radius and support channels ranging up to the tens of megabits.

No single 802.16-compliant product will operate over the entire 2-66 GHz frequency range. In fact, that frequency range represents most of the radio communications spectrum. So, why has the IEEE

defined 802.16 so broadly? The reasons are a combination of physics, regulatory issues, and user requirements.

Radio signal propagation depends on its frequency. The lower frequencies in the 802.16a standard do not require line-of-sight to work. Easing the requirement for line-of-sight between transmitter and receiver widens the range of feasible product offerings. For example, the roof of your home may be too low for line-of-sight service to work, but a non-line-of-sight implementation would enable carriers to deliver wireless broadband directly to consumers.

Vendors of wireless products are very sensitive to regulations. In the US, the FCC is responsible for the allocation of all radio frequency bands. Other countries have their own equivalent regulatory authorities. In addition to defining how the frequency spectrum is divided into bands and prescribing their usage, the FCC also specifies if a license is required to transmit on a particular band. It may also limit the power of a transmission.

The regulations are designed to minimize interference and maximize the overall utilization and usefulness of the spectrum. The ability to purchase a license for a particular piece of spectrum assures a carrier that there will be no signal interference from other carriers.

Wireless networks deployed by carriers operate at a frequency and power level that allows the signal to cover a wide region. Wireless devices intended to operate inside an enterprise would use an unlicensed frequency band and power level designated for short-distance communications. While the lack of a license requirement allows the enterprise to avoid delays and costly paperwork, there is a chance of interference from other kinds of devices that emit (intentionally or not) at the same frequency. Microwave ovens which emit over a broad spectrum are well known offenders, while 2.4 GHz wireless telephone handsets may also cause problems.

Because of the decision to define 802.16 to operate across such a broad frequency range and in many different countries, the standard supports a variety of physical layers. For example, for 10-66 GHz

line-of-sight operation, the base station uses Time Division Multiplexing (TDM). This technique allocates timeslots on a single frequency to address each customer's receiver separately as a way to share the bandwidth. Upstream customers transmit back to the base station using Time Division Multiple Access. The standard defines two choices: either the base station and customer transceiver use the same frequency, or they operate at different frequencies. Operating the equipment at different frequencies enables synchronous transmission in both directions.

Compared with line-sight-operation, 802.16 non-line-of-sight operations must be able to cope with harder technical problems at the physical layer, such as multipath propagation of radio signals as they bounce off buildings and other large objects, which can cause problems similar to the effect of acoustical echoes.

Unlike fiber or copper cable technologies, 802.16 deployments must deal with changeable environmental factors. Rain can interfere with reception. The 802.16 specification includes radio link control to establish initial parameters when links come up as well as to alter them as conditions change. Just as cell phones adjust their power consumption in relation to their proximity to a base station, 802.16 equipment will continue to monitor link quality after initialization and will adjust transmission parameters accordingly.

ARE WE THERE YET?

The WiMAX (Wireless Interoperability Microwave Access) industry consortium's charter is to promote the "deployment of broadband wireless access networks by using a global standard and certifying interoperability of products and technologies." With industry leaders such as Intel and Nokia among its members, it stands foursquare behind 802.16. To promote interoperability, WiMAX is developing system profiles of supported features and testing procedures for standards conformance and interoperability.

However, with the availability of products still a year or more away, and standards work on enhancements ongoing, it is hard to predict at this point exactly how successful 802.16 will be, what

products will be coming on the market, and when significant deployment will begin. One possibility is that it will become a technology of choice in the carrier market; however, it is hard to judge what 802.16's role in the enterprise will be. Will its use be limited to broadband access, or will it be used for more?

As it is, wireless is one of the more active areas in network technology investment and product development. If the timing is right, when the economy picks up, 802.16 could be in the sweet spot for an infusion of investment and innovation. In our next article, we will discuss in greater detail how the 802.16 technology actually works and compare its potential for success with the already popular 802.11 standard.

By enabling quick and relatively inexpensive deployment of broadband services infrastructure, the IEEE 802.16 standards for wireless broadband access have the potential to finally address the long-standing "last mile" problem that has plagued the data and telecom carrier industries. Now let's delve into the nitty-gritty details of how the standards work and what data networking services they enable.

WIRELESS SUPPORT FOR DATA NETWORKING SERVICES

Having discussed the physical layer earlier, 802.16 defines a Media Access Control (MAC) layer. The capabilities of this layer allow 802.16 to support a wide array of data networking services, including many services that are already familiar to corporate and residential users using copper or fiber networks. Because they provide the basis for these services, support for both ATM and packet operations was a requirement in the 802.16 design. ATM is important because of its role in telecom carrier infrastructure. For example, ATM is often used to support DSL services. ATM is also widely used to support voice transmissions. When it comes to packet operation, 802.16 supports all of the "usual suspects," including IPv4, IPv6, Ethernet, and VLAN services.

802.16 accomplishes all of this by dividing its MAC layer into separate sublayers that handle different services, provide common core functions,

and implement wireless privacy. Overall, this design gives 802.16 both flexibility and efficiency at the same time.

The convergence sublayers map the different services into the core MAC common part sublayer. In addition to relating service data units to MAC connections, the convergence sublayers are responsible for decisions about bandwidth allocation and QoS. They also embody functions to get the most efficient use (maximum effective bits transmitted and received) out of the radio frequencies themselves.

The common part sublayer is connection-oriented. All services, even connectionless services such as Ethernet and IP, are mapped into a MAC connection. The common part sublayer includes mechanisms for requesting bandwidth, including bandwidth on demand — a very attractive option for many carriers.

SECURITY AND MORE SECURITY

Authentication and registration are part of the 802.16 MAC common part sublayer. Authentication is based on the use of [PKI technology-based](#) X.509 digital certificates. Just as every Ethernet interface comes with its own unique Ethernet MAC address, every 802.16 customer transceiver will include one built-in certificate for itself and another for its manufacturer.

These certificates allow the customer transceiver to uniquely authenticate itself back to the base station. The base station can then check to see if the customer transceiver is authorized to receive service. If the database lookup succeeds, the base station sends the customer transceiver an encrypted authorization key, using the customer transceiver's public key. This authorization key is used to encrypt and protect any transmissions that follow.

Link privacy is implemented as part of another MAC sublayer, called the Privacy sublayer. It operates below the common part sublayer. It is based on the Privacy Key Management protocol that is part of the DOCSIS BPI+ specification. The changes to the DOCSIS design are aimed at integration with the 802.16 MAC. They also enable 802.16 to take advantage of recent advances in cryptographic techniques.

OTHER FEATURES AND GOODIES

802.16 supports a wide variety of QoS (Quality of Service) options, based on mechanisms used in DOCSIS. Bandwidth can be allocated to a customer transceiver and managed on that basis, or it can be allocated to individual connections between the base station and the customer transceiver. Some customer transceivers will manage their own allocations, even to the extent of stealing bandwidth from one connection to help another. Customer transceivers are permitted to negotiate with the base station for changes in allocations.

These design choices enable services as diverse as connection-oriented, constant-bandwidth ATM and connectionless, bursty IP traffic to co-exist in the same box. 802.16 is flexible enough to permit a single customer transceiver to simultaneously employ one set of 802.16 MAC connections for individual ATM connections and another set for sharing among numerous IP end users.

802.16 uses scheduling services to implement bandwidth allocation and QoS. Unsolicited grant services provide a fixed, regular allocation. This mechanism is well suited for ATM or T1/E1 over ATM. There is relatively low overhead because there is no need to support requests for changes to the allocation. At the same time, delivery delay and jitter are minimized.

For flexibility, 802.16 also specifies a wide variety of mechanisms to request bandwidth allocation changes, including MAC protocol requests and various types of polling. The same mechanisms also can be applied to deliver best effort service, which makes no guarantees for throughput or delay.

In addition to extending 802.16 operations to the 2-11 GHz range, 802.16a also extends the reach of 802.16 beyond the limits of communication between a base station and a customer transceiver. It does this by enhancing the base standard to support mesh deployment. In mesh deployments, a customer transceiver can act as an intermediary between another customer transceiver and the base station. In other words, the customer transceiver is acting as a switch between locations.

802.16 VS. 802.11

It is natural to ask whether 802.16 will replace or compete with 802.11. This question will become even more pertinent once the 802.16 working group completes its work on mobility. Assuming the ratification of a standard for 802.16 mobility and good non-line-of-sight operation inside buildings, which standard should you use, or both?

802.11 is rapidly becoming established. It is cheap and easy to install, and its well-publicized problems with security are being addressed. 802.11 is normally deployed using a hotspot approach. Hotspots are chosen to provide the desired campus coverage. The access points are then attached to the corporate LAN backbone.

In comparison, there are a variety of enterprise network architectures that can be implemented using 802.16. The technology could simply connect campuses to each other or could also work directly with end-user laptops and desktop systems, perhaps replacing all or part of the wired campus backbone. While there will certainly be some overlap, the two standards have some important differences. 802.11 has wide 20 MHz channels and a MAC that is designed to support tens of users over a relatively small radius of 100-300 meters. (MACs that use more power to attain the 300m limit may be non-standard.) On the other hand, 802.16a allows the operator to control channel bandwidth, and its MAC is designed to support thousands of simultaneous users over a 50 km radius. (This reach has not been demonstrated yet; working products may have a somewhat smaller range).

The maximum data rate for 802.16 is higher than that of 802.11, partially because it gets nearly twice the number of bits per second from a single Hertz of frequency. In addition, 802.16 offers a variety of QoS choices, while 802.11 supports only best-effort service (with the possible addition of priorities, as in 802.11e).

Because of these options, 802.16a requires more configuration in order to manage the users and the services they receive. The fact that 802.16a supports mesh network topology while 802.11 does not may be more significant to carriers than to

enterprise IT managers, given the wide radius of coverage offered by a single 802.16 base station.

Even more important than any of these technical differences are the issues of when the 802.16 standards will be completed and when 802.16 products will become available. Millions of 802.11 NIC cards are being installed today, while 802.16 products will not be available for another twelve to eighteen months. By that time, there will be a very large and significant installed base of 802.11 interfaces in offices and homes. This will provide considerable inertia against any change from 802.11 to 802.16. For the pendulum to swing in the 802.16 direction, there must be significant and compelling benefits for enterprises and individual users to make the switch.

WHAT DOES THE FUTURE HOLD?

As you can see, much care and work have gone into the design of 802.16. Becoming an expert will mean learning many details. However, it is worth understanding at least the rudiments of this technology because it has the potential to revolutionize how companies and carriers design and evolve their networks.

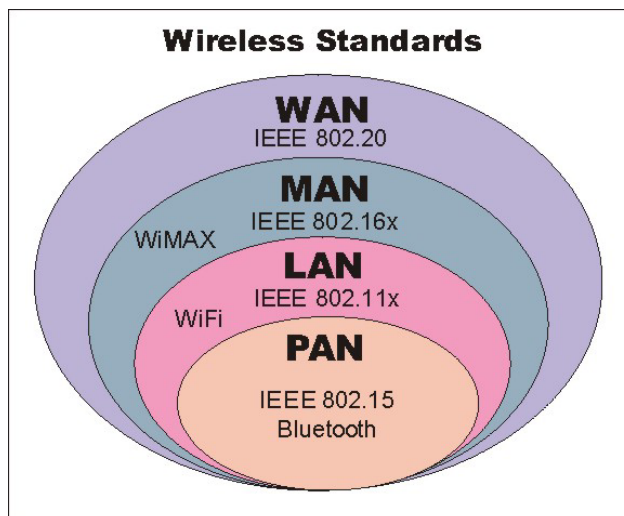
At the end of the day, everyone would like to be able to do more while spending less money, and obviating the need for wires can result in a considerable reduction in infrastructure costs, which means wireless data networking — in its many forms — is clearly here to stay.

WiMAX TECHNICAL OVERVIEW

INTRODUCTION: THE IEEE 802.16 STANDARD FOR BROADBAND WIRELESS

Many operators and service providers may be unfamiliar with the details of the IEEE 802.16* standard, but this wireless technology is about to revolutionize the broadband wireless access industry. The 802.16 standard, the “Air Interface for Fixed Broadband Wireless Access Systems,” is also known as the IEEE WirelessMAN* air interface. This technology is designed from the ground up to provide wireless last-mile broadband access in the Metropolitan Area Network (MAN), delivering performance comparable to traditional cable, DSL, or T1 offerings. The principal advantages of systems based on 802.16 are multi-fold: the ability to quickly provision service, even in areas that are hard for wired infrastructure to reach; the avoidance of steep installation costs; and the ability to overcome the physical limitations of traditional wired infrastructure. Providing a wired broadband connection to a currently underserved area through cable or DSL can be a time-consuming, expensive process, with the result that a surprisingly large number of areas in the US and throughout the world do not have access to broadband connectivity. 802.16 wireless technology provides a flexible, cost-effective, standards-based means of filling existing gaps in broadband coverage, and creating new forms of broadband services not envisioned in a “wired” world.

Drawing on the expertise of hundreds of engineers from the communications industry, the IEEE has established a hierarchy of complementary wireless standards. These include IEEE 802.15 for the Personal Area Network (PAN), IEEE 802.11 for the Local Area Network (LAN), 802.16 for the Metropolitan Area Network, and the proposed IEEE 802.20 for the Wide Area Network (WAN). Each standard represents the optimized technology for a distinct market and usage model and is designed to complement the others.



A good example is the proliferation of home and business wireless LANs and commercial hotspots based on the IEEE 802.11 standard. This proliferation of WLANs is driving the demand for broadband connectivity back to the Internet, which 802.16 can fulfill by providing the outdoor, long range connection back to the service provider. For operators and service providers, systems built upon the 802.16 standard represent an easily deployable “third pipe” capable of delivering flexible and affordable last-mile broadband access for millions of subscribers in homes and businesses throughout the world.

DESIGNED FROM THE GROUND UP FOR METROPOLITAN AREA NETWORKS

In January 2003, the IEEE approved the 802.16a standard which covers frequency bands between 2 GHz and 11 GHz. This standard is an extension of the IEEE 802.16 standard for 10 – 66 GHz published in April 2002. These sub 11 GHz frequency ranges enable non line-of-sight performance, making the IEEE 802.16a standard the appropriate technology for last-mile applications where obstacles like trees and buildings are often present and where base stations may need to be unobtrusively mounted on the roofs of homes or buildings rather than towers on mountains.

The most common 802.16a configuration consists of a base station mounted on a building or tower that communicates on a point to multi-point basis with

subscriber stations located in businesses and homes. 802.16a has up to 30 miles of range with a typical cell radius of 4 – 6 miles. Within the typical cell radius, non-line-of-sight performance and throughputs are optimal. In addition, 802.16a provides an ideal wireless backhaul technology to connect 802.11 wireless LANs and commercial hotspots with the Internet.

802.16a wireless technology enables businesses to flexibly deploy new 802.11 hotspots in locations where traditional wired connections may be unavailable or time consuming to provision and provides service providers around the globe with a flexible new way to stimulate growth of the residential broadband access market segment.

With shared data rates up to 75 Mbps, a single “sector” of an 802.16a base station – where sector is defined as a single transmit/receive radio pair at the base station—provides sufficient bandwidth to simultaneously support more than 60 businesses with T1-level connectivity and hundreds of homes with DSL-rate connectivity, using 20 MHz of channel bandwidth. To support a profitable business model, operators and service providers need to sustain a mix of high-revenue business customers and high-volume residential subscribers. 802.16a helps meet this requirement by supporting differentiated service levels, which can include guaranteed T1-level services for business, or best effort DSL-speed service for home consumers.

The 802.16 specification also includes robust security features and the Quality of Service needed to support services that require low latency, such as voice and video. 802.16 voice service can be either traditional Time Division Multiplexed (TDM) voice or Voice over IP (VoIP).

WIMAX WIRELESS APPLICATIONS

The 802.16 standard will help the industry provide solutions across multiple broadband segments:

1. Cellular backhaul. Internet backbone providers in the U.S. are required to lease lines to third-party service providers, an arrangement that has tended to

make wired backhaul relatively affordable. The result is that only about 20 percent of cellular towers are backhauled wirelessly in the U.S. In Europe, where it is less common for local exchange carriers to lease their lines to competitive third parties, service providers need affordable alternatives.

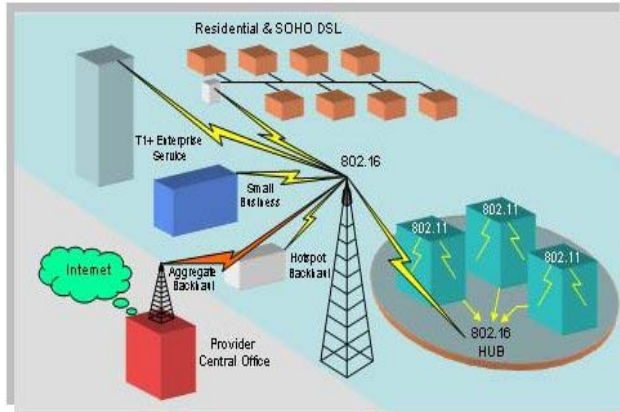
Subsequently, wireless backhaul is used in approximately 80 percent of European cellular towers. With the potential removal of the leasing requirement by the FCC, U.S. cellular service providers will also look to wireless backhaul as a more cost-effective alternative. The robust bandwidth of 802.16a technology makes it an excellent choice for backhaul for commercial enterprises such as hotspots as well as point-to-point backhaul applications.

2. Broadband on-demand. Last-mile broadband wireless access can help to accelerate the deployment of 802.11 hotspots and home/small office wireless LANs, especially in those areas not served by cable or DSL or in areas where the local telephone company may have a long lead time for provisioning broadband service. Broadband Internet connectivity is mission critical for many businesses, to the extent that these organizations may actually re-locate to areas where service is available. In today’s market, local exchange carriers have been known to take three months or more to provision a T1 line for a business customer, if the service is not already available in the building. Older buildings in metropolitan areas can present a tangle of wires that can make it difficult to deploy broadband connections to selected business tenants. 802.16a wireless technology enables a service provider to provision service with speed comparable to a wired solution in a matter of days, and at significantly reduced cost. 802.16a technology also enables the service provider to offer instantly configurable “on demand” high-speed connectivity for temporary events including trade shows that can generate hundreds or thousands of users for 802.11 hotspots.

In these applications, operators use 802.16a solutions for backhaul to the core network. Wireless technology makes it possible for the service provider to scale-up or scale-down service levels, literally within seconds of a customer request. “On demand” connectivity also benefits businesses, such

as construction sites, that have sporadic broadband connectivity requirements. Premium “on demand” last-mile broadband services represent a significant new profit opportunity for operators.

3. Residential broadband: filling the gaps in cable and DSL coverage.



Practical limitations prevent cable and DSL technologies from reaching many potential broadband customers. Traditional DSL can only reach about 18,000 feet (3 miles) from the central office switch, and this limitation means that many urban and suburban locations may not be served by DSL connections. Cable also has its limitations. Many older cable networks have not been equipped to provide a return channel, and converting these networks to support high-speed broadband can be expensive.

The cost of deploying cable is also a significant deterrent to the extension of wired broadband service in areas with low subscriber density. The current generation of proprietary wireless systems are relatively expensive for mass deployments because, without a standard, few economies of scale are possible. This cost inefficiency will all change with the launch of standards-based systems based on 802.16. In addition, the range of 802.16a solutions, the absence of a line of sight requirement, high bandwidth, and the inherent flexibility and low cost helps to overcome the limitations of traditional wired and proprietary wireless technologies.

4. Underserved areas. Wireless Internet technology based on IEEE 802.16 is also a natural choice for underserved rural and outlying areas with low population density. In such areas, local utilities and

governments work together with a local Wireless Internet Service Provider (WISP) to deliver service. Recent statistics show that there are more than 2,500 WISPs who take advantage of license-exempt spectrum to serve over 6,000 markets in the U.S. [Source: ISP-Market 2002]. On an international basis, most deployments are in licensed spectrum and are deployed by local exchange carriers who require voice services in addition to high-speed data. This is because in these areas the wired infrastructure either does not exist or does not offer the quality to support reliable voice, let alone high-speed data.

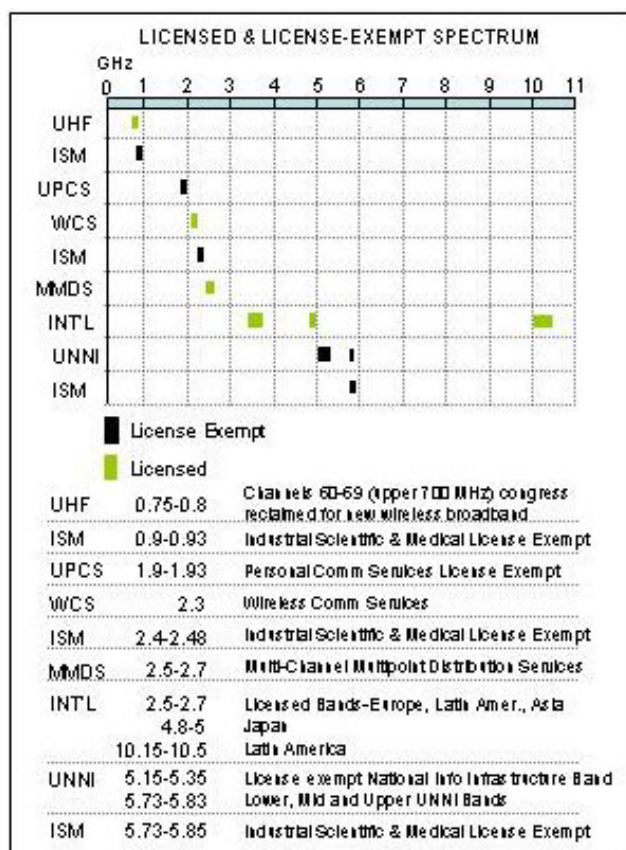
The term, “Wireless Local Loop” is often used to describe such applications, since it is used as a substitute for traditional copper phone wire in the local loop.

5. Best-connected wireless service. As the number of IEEE 802.11 hotspots proliferates, users will naturally want to be wirelessly connected, even when they are outside the range of the nearest hotspot. The IEEE 802.16e extension to 802.16a introduces nomadic capabilities which will allow users to connect to a WISP even when they roam outside their home or business, or go to another city that also has a WISP.

THROUGHPUT, SCALABILITY, QOS, AND SECURITY

Throughput. By using a robust modulation scheme, IEEE 802.16 delivers high throughput at long ranges with a high level of spectral efficiency that is also tolerant of signal reflections. Dynamic adaptive modulation allows the base station to tradeoff throughput for range. For example, if the base station cannot establish a robust link to a distant subscriber using the highest order modulation scheme, 64 QAM (Quadrature Amplitude Modulation), the modulation order is reduced to 16 QAM or QPSK (Quadrature Phase Shift Keying), which reduces throughput and increases effective range.

Scalability. To accommodate easy cell planning in both licensed and license-exempt spectrum worldwide, 802.16 supports flexible channel bandwidths.



For example, if an operator is assigned 20 MHz of spectrum, that operator could divide it into two sectors of 10 MHz each, or 4 sectors of 5 MHz each. By focusing power on increasingly narrow sectors, the operator can increase the number of users while maintaining good range and throughput. To scale coverage even further, the operator can re-use the same spectrum in two or more sectors by creating proper isolation between base station antennas.

Coverage. In addition to supporting a robust and dynamic modulation scheme, the IEEE 802.16 standard also supports technologies that increase coverage, including mesh topology and “smart antenna” techniques. As radio technology improves and costs drop, the ability to increase coverage and throughput by using multiple antennas to create “transmit” and/or “receive diversity” will greatly enhance coverage in extreme environments.

Quality of Service. Voice capability is extremely important, especially in underserved international markets. For this reason the IEEE 802.16a standard includes Quality of Service features that enable

services including voice and video that require a low-latency network. The grant/request characteristics of the 802.16 Media Access Controller (MAC) enables an operator to simultaneously provide premium guaranteed levels of service to businesses, such as T1-level service, and high-volume “best-effort” service to homes, similar to cable-level service, all within the same base station service area cell.

Security. Privacy and encryption features are included in the 802.16 standard to support secure transmissions and provide authentication and data encryption.

BENEFITS OF STANDARDS

Standards are important for the wireless industry because they enable economies of scale that can bring down the cost of equipment, ensure interoperability, and reduce investment risk for operators.

Without industry-wide standards, equipment manufacturers must provide all the hardware and software building blocks and platforms for themselves, including the fundamental silicon, the subscriber station, the base station, and the network management software that is used to provision services and remotely manage the subscriber station. With the 802.16 standard in place, suppliers can amortize their research and development costs over much higher product volume. For example, a volume silicon supplier can supply the same standard component to many equipment makers at a far lower cost than would be possible if the device manufacturers were required to develop proprietary silicon for use only by their equipment. Standards also specify minimum performance criteria for equipment, enabling a common broadband wireless access baseline platform that equipment manufacturers can use as the foundation for ongoing innovations and faster time-to-market. With its broad industry support, the 802.16 standard lets device manufacturers and solutions vendors do what they do best, achieving overall price/performance improvements and opening mass-market opportunities that cannot be equaled by proprietary approaches.

WIMAX FOCUSES ON INTEROPERABILITY

WiMAX (the Worldwide Interoperability for Microwave Access Forum) is a non-profit corporation formed by equipment and component suppliers, including Intel Corporation, to promote the adoption of IEEE 802.16 compliant equipment by operators of broadband wireless access systems. The organization is working to facilitate the deployment of broadband wireless networks based on the IEEE 802.16 standard by helping to ensure the compatibility and interoperability of broadband wireless access equipment. In this regard, the philosophy of WiMAX for the wireless MAN is comparable to that of the Wi-Fi* Alliance in promoting the IEEE 802.11 standard for wireless LANs.

In an effort to bring interoperability to Broadband Wireless Access, WiMAX is focusing its efforts on establishing a unique subset of baseline features grouped in what is referred to as “System Profiles” that all compliant equipment must satisfy. These profiles will establish a baseline protocol that allows equipment from multiple vendors to interoperate, and that also provides system integrators and service providers with the ability to purchase equipment from more than one supplier. System Profiles can address the regulatory spectrum constraints faced by operators in different geographies. For example, a service provider in Europe1 operating in the 3.5 GHz band who has been allocated 14 MHz of spectrum is likely to want equipment that supports 3.5 and/or 7 MHz channel bandwidths and TDD (time-division duplex) or FDD (frequency-division duplex) operation. Similarly, a WISP in the U.S. using license-exempt spectrum in the 5.8 GHz UNII band may desire equipment that supports TDD and a 10 MHz bandwidth. WiMAX will establish a structured compliance procedure based upon the proven test methodology specified by ISO/IEC 96462.

The process starts with standardized Test Purposes written in English, which are then translated into Standardized Abstract Test Suites in a language called TTCN3. In parallel, the Test Purposes are also used as input to generate test tables referred to as the PICS (Protocol Implementation Conformance Statement) pro forma. The end result is a complete set of test tools that WiMAX will make available to

equipment developers so they can design in conformance and interoperability during the earliest possible phase of product development. Typically, this activity will begin when the first integrated prototype becomes available. Ultimately, the WiMAX suite of conformance tests, in conjunction with interoperability events, will enable service providers to choose from multiple vendors of broadband wireless access equipment that conforms to the IEEE 802.16a standard and that is optimized for their unique operating environment. Internationally, WiMAX will work with ETSI, the European Telecommunications Standards Institute, to develop similar test suites for the ETSI HIPERMAN standard for European broadband wireless metropolitan area access.

WiMAX has key benefits for operators. By choosing interoperable, standards-based equipment, the operator reduces the risk of deploying broadband wireless access systems.

Economies of scale enabled by the standard help reduce monetary risk.

Operators are not locked in to a single vendor because base stations will interoperate with subscriber stations from different manufacturers. Ultimately, operators will benefit from lower-cost and higher-performance equipment, as equipment manufacturers rapidly create product innovations based on a common, standards-based platform.

INTEL CORPORATION AND THE IEEE 802.16 STANDARD

To help accelerate the deployment of wireless broadband access Intel Corporation is taking a leading role in industry-enabling programs and working to build the ecosystem for IEEE 802.16. Intel’s involvement includes:

Board member of the Wireless Communications Association International (WCA), including chair of the Rural Broadband Task Force and chair of the License Exempt Alliance.

A lead role in accelerating the completion of conformance test specifications (802.16d) and

mobility specifications (802.16e) and chair of the IEEE 802 Handoff Study Group.

CONCLUSION

The cost and complexity associated with traditional wired cable and telephone infrastructure have resulted in significant broadband coverage gaps in the U.S. and international geographies. Early attempts to use wireless technology to fill these coverage gaps have involved a number of proprietary solutions for wireless broadband access that have fragmented the market without providing significant economies of scale.

High-speed wireless broadband technology based on the IEEE 802.16 standard promises to open new, economically viable market opportunities for operators, wireless Internet service providers, and equipment manufacturers. The flexibility of wireless technology, combined with the high throughput, scalability, long range and Quality of Service features of the IEEE 802.16 standard will help fill the broadband coverage gaps and reach millions of new residential and business customers worldwide.

The WiMAX Forum is an industry group focused on creating system profiles and conformance programs to help ensure interoperability among devices from different manufacturers. Intel is actively participating in these industry efforts to help reduce investment risks for operators and service providers while enabling them to more cost effectively take advantage of the tremendous market potential of wireless broadband access.

FOR MORE INFORMATION

More information on the IEEE 802.16 standard for broadband wireless and information on the WiMAX Forum, is available at: www.wimaxforum.org and www.ieee802.org/16

TECHNICAL REFERENCES

Technical Overview of 802.16: [802.16 Tutorial](#)
802.16 Technical Specifications:
[IEEE 802.16's Published Standards and Drafts](#)
IEEE 802.16 Working Group: ["802.16"](#)
WiMAX Industry Association: [WiMAX Forum](#)

OPTICAL SYSTEMS OVERVIEW

Free Space Optics (FSO) and Hybrid FSO/Radio (HFR) are fixed wireless communications technologies that are capable of delivering ultra broadband services over the air. FSO and HFR systems can quickly deliver a gigabit of capacity, over the last mile, without the time and costs associated with trenching to install fiber. Additionally, these technologies are unlicensed.

FSO systems are based on laser communications between two optical transceivers, over the air, aligned to each other with a clear line of site. Typically, the FSO transceivers are mounted on building rooftops or behind a window in the building. The optical transceiver consists of a laser transmitter and a detector (photo diode) to provide full-duplex operation at rates up to OC-12 (622 Mbps).

[AirFiber®](#), for example, has significantly improved the performance of standalone FSO systems by integrating a millimeter wave radio into the system. The resulting solution is HFR for Hybrid FSO/Radio. HFR is capable of providing 99.999% availability in all-weather at over a kilometer. Competitive products are also available from [Terabeam®](#). Both AirFiber and Terabeam also can provide redundant microwave capable link equipment as well as the primary laser optic links. Another product suite from [MRV®](#) provides similar capabilities as well.

Optical systems can be deployed extremely quickly for either permanent or temporary applications. Temporary applications include disaster recovery or when very high bandwidth is needed, for a short period of time, for an event.

As free space optical technology has evolved, telecommunications carriers are now deploying free space optical systems for a variety of metropolitan area applications. However, not all free space optic equipment on the market is actually carrier class. Free space optical systems typically require the following capabilities in order to be classified as carrier class:

- Ability to operate safely outdoors, in harsh weather environments
- Automatic tracking and realignment of the beam to counteract building sway
- "Self healing" links over alternative FSO links in case of service interruption (may be microwave backup in 40-60 GHz frequency range)
- Immunity to bit errors, should a beam block occur, supporting a guaranteed BER of 10⁻¹²
- Certified eye safe to Class 1 or Class 1M (as per IEC 60825-1)
- Dynamic laser power control for reliable laser operation and extended laser life
- Integrated management channel that does not interfere with the payload
- Carrier class Element Management System (EMS) for monitoring and management of equipment

Equipment available today is capable of establishing point-to-point solutions, and are scalable to fully redundant OC-12 (622 Mbps) solutions if need be. Pricing in late 2002 for optical solutions of this type typically ranged between \$30K and \$40K for a non-redundant OC-3 (two ends, 155 Mbps). The cost of these systems is expected to decrease significantly in the next 12-24 months.

Applications best suited for using optical link technologies are:

- Telecommunications Carriers
- Building LECs (Building Local Exchange Carriers)
- Building Owners and Property Managers
- Business Customers
- Campus-based Business Customers
- Wireless Network Back-Haul
- Internet Service Providers (ISPs)

LEGACY COPPER TECHNOLOGY OVERVIEW

COPPER ACCESS TECHNOLOGIES

Bandwidth limitations of voice circuits (your typical phone line) do not come from the subscriber line, however. They come from the core network. Filters at the edge of the core network limit voice grade bandwidth to 3.3 kHz. Without filters, copper access lines can pass frequencies into MHz regions, albeit with substantial loss over distance. Indeed, this attenuation, which increases as lines get longer or frequencies increase, dominates the constraints on data rate over twisted pair wire. Practical limits on data rate *in one direction* compared to line length (of 24 gauge twisted pair) are:

- DS1 (T1) 1.544 Mbps 18,000 feet
- E1 2.048 Mbps 16,000 feet
- 1/4 STS-1 12.960 Mbps 4,500 feet
(1/4 DS-3)
- 1/2 STS-1 25.920 Mbps 3,000 feet
(1/2 DS-3)
- STS-1 (DS-3) 51.840 Mbps 1,000 feet

Subscriber loop configurations vary tremendously around the world. In some countries 18,000 feet covers virtually every subscriber; in others, such as the United States, 18,000 feet often covers less than 80% of subscribers. Nearly 20% or so of existing telco lines were equipped with loading coils or some with bridge taps or other echo cancellation devices, and they cannot be used for any DSL service (including ISDN) without rework. Most telephone companies have had programs to clean up and shrink average loop length underway for a number of years, largely to stretch the capacity of existing central offices. The typical technique involves installation of access nodes remote from central offices, creating so-called Distribution Areas with maximum subscriber loops of 6000 feet from the access node. Remote access nodes are often fed by T1/E1 lines (now using HDSL) or fiber. In many suburban communities a Distribution Area connects an average of 1500 premises; in urban areas, the figure is often double, or about 3000 premises. As a rule of thumb, the number of premises served dwindles as subscriber service data rates increase, generally driven by cost factors.

You now have enough information to be a network planner, presuming the marketing department has handed you a stable list of applications. If that list does not include digital live television or HDTV (but does include video on demand and Internet access), then a data rate of 1.5 Mbps per subscriber terminal downstream may suffice, and you can offer it to virtually everyone within 18,000 feet, the nominal range of ISDN. For subscribers with shorter lines, either to a central office or remote access node, you can offer more than one channel to more than one premises terminal. If digital live television is on the list, then you have to offer at least 6 Mbps, and you may be limited to 4500 foot distances to supply more than one channel at a time. (This fact is the heart of telephone company interest in wireless broadcast digital TV). Clearly HDTV, demanding as much as 24 Mbps per channel, could only be delivered over the shortest loop lengths. Of course, this offering of digital services over existing twisted-pair lines requires transceivers, special modems capable of dazzling data rates when one considers the age and original intentions of twisted-pair wiring technology. It turns out that this effort to use twisted pair for high speed information began many years ago.

T1 OR E1 CIRCUITS

In the early sixties engineers at Bell Labs created a voice multiplexing system that first digitized a voice signal into a 64 kbps data stream (representing 8000 voltage samples a second with each sample expressed in 8 bits) and then organized twenty four of them into a framed data stream, with some conventions for figuring out which 8 bit slot went where at the receiving end. The resulting frame was 193 bits long, and created an equivalent data rate of 1.544 Mbps. The structured signal was called DS-1, but it has acquired an almost colloquial synonym -- T1 -- which also describes the raw data rate, regardless of framing or intended use. AT&T deployed DS-1 in the interoffice plant starting in the late sixties (almost all of which has since been replaced by fiber), and by the mid-seventies was using DS-1 in the feeder segment of the outside loop plant.

Until recently, T1 and E1 circuits were implemented over copper wire by using crude transceivers with a self-clocking Alternate Mark Inversion (AMI) protocol. AMI requires repeaters 3000 feet from the central office and every 6000 feet thereafter, and takes 1.5 MHz of bandwidth, with a signal peak at 750 kHz

(U.S. systems). To a transmission purist, this is profligate and ugly, but it has worked for many years and hundreds of thousands of lines (T1 and E1) exist in the world today.

Telephone companies originally used T1/E1 circuits for transmission between offices in the core switching network. Over time they tariffed T1/E1 services and offered them for private networks, connecting PBXs and T1 multiplexers together over the Wide Area Network (WAN). Today T1/E1 circuits can be used for many other applications, such as connecting Internet routers together, bringing traffic from a cellular antenna site to a central office, or connecting multimedia servers into a central office. An increasingly important application is in the so-called feeder plant, the section of a telephone network radiating from a central office to remote access nodes that in turn service premises over individual copper lines. T1/E1 circuits feed Digital Loop Carrier (DLC) systems that concentrate 24 or 30 voice lines over two twisted pair lines from a central office, thereby saving

copper lines and reducing the distance between an access point and the final subscriber.

However, that T1/E1 is not a very suitable service for connecting to individual residences. First of all, AMI is so demanding of bandwidth, and corrupts cable spectrum so much, that telephone companies cannot put more than one circuit in a single 50 pair cable, and must put none in any adjacent cables. Offering such a system to residences would be equivalent to pulling new shielded wire to most of them. Second, until recently no application going to the home demanded such a data rate. Third, even now, as data rate requirements accelerate with the hope of movies and high speed data for everyone, the demands are highly asymmetric -- bundles downstream to the subscriber, and very little upstream in return -- and many situations will require rates above T1 or E1. In general, high speed data services to the home will be carried by ADSL, VDSL (or similar types of modems over CATV lines), or [eventually] even fiber.

ARIZONA SERVICE PROVIDER DIRECTORY



ArizonaTele.com Providers List

This is an alphabetical list of the ArizonaTele.com providers in the ATD. Links lead to provider profile details. The listings below are Hyperlinks to the Arizona Telecommunications and Information Council (ATIC) website which provides summaries for each of the below listed providers.

Please visit <http://www.arizonatele.com> for additional up to date telecom information.

[2600 Tower](#)
[3rd Pipe Communications, Inc](#)
[Accipiter Communications Inc.](#)
[Adelphia Business Solutions Inc.](#)
[Adelphia Communications Corporation](#)
[Advanced Digital Systems \(ADS\) Inc.](#)
[AeroGen Broadband Inc.](#)
[airBand Communications Inc.](#)
[AllCom USA Inc.](#)
[Allegiance Telecom Inc.](#)
[Alliance Group Services Inc.](#)
[American Fiber Network \(AFN\) Inc.](#)
[Americom Inc.](#)
[Arch Wireless Inc.](#)
[Arizona Cable/Congress Cablevision](#)
[AT&T Business Services](#)
[AT&T Consumer Services](#)
[AT&T Wireless Services Inc.](#)
[Az Com Wireless Technologies](#)
[Boomerang Wireless](#)
[Broadband Laboratories](#)
[Broadwing Inc.](#)
[Cable & Wireless USA Inc.](#)
[Cable One](#)
[Cable One, Inc](#)
[Cable One, Inc \(Page AZ\)](#)
[Cable One, Inc. \(Globe, AZ\)](#)
[CableONE](#)
[CableONE 340 N.9th St. Show Low](#)
[CableVision](#)
[Cellular One \(of Northeastern Arizona\)](#)
[Cellular One \(West\)](#)
[Central Arizona Communications](#)
[CenturyTel Inc.](#)
[Cingular Wireless](#)
[Citizens Communications Company](#)

[CityNet Telecommunications Inc.](#)
[Clear Sky Broadband, Inc](#)
[ClearPath Telecom LLC](#)
[ClearWorks Communications](#)
[Cole Companies](#)
[Comcast Cable Communications Inc.](#)
[Community Information & Referral Services](#)
[Compass Broadband Inc.](#)
[Computer Intelligence2 Inc. \(CI2\)](#)
[Covad Communications Group Inc.](#)
[Cox Business Services](#)
[Cox Communications Inc. \(Phoenix\)](#)
[Cricket Communications](#)
[CSG Wireless Inc.](#)
[Cyber Trails](#)
[Dancris Telecom LLC](#)
[Deru Communications Corporation](#)
[DMJ Communications Inc.](#)
[Downtown Phoenix Technology Exchange.](#)
[Downtown Tucson Telecom Center](#)
[dPi-TeleConnect LLC](#)
[Eagle West Cable Co.](#)
[EarthLink Inc.](#)
[El Paso Global Networks](#)
[Electric Lightwave Inc. \(ELI\)](#)
[Ensynch Inc.](#)
[Ernest Communications Inc.](#)
[Eschelon Telecom Inc.](#)
[espire Communications Inc.](#)
[espire Communications Inc.](#)
[EZColo.com](#)
[Flex Solutions Inc.](#)
[Fort Mojave Inc.](#)
[Fourthstage Technologies Inc.](#)
[Gain Communications Inc.](#)
[Genuity Inc.](#)
[Gila River Telecommunications Inc.](#)
[Global Crossing Telecommunications Inc.](#)
[Globalstar USA](#)
[GTECH Holdings Corporation](#)
[Hughes Network Systems Inc.](#)
[iBIZ Technology Corporation](#)
[ILD Telecommunications Inc.](#)
[Inflow Inc.](#)
[InfraNext Corp.](#)
[IntelliCommunities Inc.](#)
[Inter-Tel Incorporated](#)

[Intermedia Communications Inc.](#)
[International FiberCom Inc.](#)
[Internet Commerce & Communications \(IC&C\)](#)
[IPVoice Communications Inc.](#)
[Iridium Satellite LLC](#)
[Kite Networks Inc.](#)
[Koss Communication Systems Inc.](#)
[Level 3 Communications Inc.](#)
[Local Gateway Exchange Inc.](#)
[MasTec Inc.](#)
[Max-Tel Communications Inc.](#)
[MCI Worldcom Communications Inc.](#)
[McLeodUSA Inc.](#)
[Mediacom of Arizona LLC](#)
[Metricom Inc.](#)
[Metro North Corporate Park](#)
[Midvale Telephone Exchange Inc.](#)
[Mohave Cellular LP](#)
[Motient Corporation](#)
[Mountain Telecommunications Inc.](#)
[Mpower Communications Corp.](#)
[Navajo Communications Company Inc.](#)
[Netbeam Incorporated](#)
[Nextel Communications Inc.](#)
[OmniSky Corporation](#)
[OnePoint Communications Corp.](#)
[OPEX Communications Inc.](#)
[Opnix Inc.](#)
[Park Central Technology Center](#)
[Preferred Carrier Services](#)
[Qwest Communications International Inc.](#)
[Regal Diversified Inc.](#)
[Renaissance Networking Inc. \(RNI\)](#)
[Rhythms NetConnections Inc.](#)
[S.T.S. Inc.](#)
[Saddleback Communications](#)
[Salt River Project \(SRP\)](#)
[San Carlos Apache Telecommunications Utility](#)
[Satellite LLC](#)
[SAVVIS Communications Corporation](#)
[SBC Telecom Inc.](#)

[Sky Harbor Technology Exchange](#)
[Southwest Gas Corporation](#)
[Sprint Broadband Direct](#)
[Sprint Corporation](#)
[Sprint PCS Group](#)
[StarBand Communications Inc.](#)
[Sulphur Springs Valley Electric Cooperative Inc.](#)
[Switch & Data Facilities Co.](#)
[SwitchX](#)
[Systems Technology Group Inc. \(STG\)](#)
[Table Top Telephone Company Inc.](#)
[TDS Telecom](#)
[Technology Alliance Group LLC \(TAG\)](#)
[Technology Center of Scottsdale](#)
[Teknon Corporation](#)
[Telecom Center Downtown Phoenix](#)
[Telecom Center North Phoenix](#)
[Teligent Inc.](#)
[TerraLinx Inc.](#)
[Tesinc Inc.](#)
[The Ideal Communications Building](#)
[The River Internet Access Co.](#)
[Time Warner Telecom Inc.](#)
[Tohono O'odham Utility Authority](#)
[Tucson Electric Power Company](#)
[USA Digital Communications Inc](#)
[Valley TeleCom Group](#)
[VelociTel Inc.](#)
[Verde Online](#)
[Verizon California Inc. -- Arizona Operations](#)
[Verizon Communications Inc.](#)
[Verizon Wireless Inc.](#)
[VoiceStream Wireless Corporation](#)
[W Inc.](#)
[Western Cablevision Inc.](#)
[WideOpenWest LLC \(WOW\)](#)
[Williams Communications LLC](#)
[Winstar Communications Inc.](#)
[XO Communications Inc.](#)

QWEST DSL SERVICE PRICING & ARIZONA ISP RESELLERS

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<http://www.aznetgate.com>

Broadband Laboratories
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<http://www.bblabs.com/>

Convergent Internet Solutions (CIS)
Phoenix metro areas, Flagstaff, Prescott
(800-227-0876 extension 2510
<http://www.cisaz.com/>

Cybertrails
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(888) 841-4DSL
<http://www.cybertrails.com/>

Dakotacom.net
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(520) 745-3900
<http://www.dakotacom.net/>

Dancris Telecom LLC
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(480) 874-2700
<http://www.dancris.com/>

Deru Internet
Phoenix metro areas
(480) 998-7237
<http://www.deru.com/>

DirectDSL
Flagstaff, Phoenix metro
(480) 497-2578
<http://www.directdsl.net/>
EMR Data Services Inc.
Phoenix
(800) 851-8535
<http://www.emrcorp.net/>

ENT Inc.
Tucson
(520) 322-5555 ext. 4001
<http://www.entinc.net/>

Extreme Internet
Phoenix

(602) 368-4638
<http://www.extremezone.com/>

FastQ Communications
Flagstaff, Metro Phoenix, Prescott
(602) 553-8966
<http://www.fastq.com/>

fastucson.net
Tucson
(520) 618-9375
<http://www.fastucson.net/>

First Internet
All metro Phoenix cities
(480) 839-1070
http://www.firstinter.net/services/serv_dsl.php3

Gain Communications
Tucson
(520) 388-9100
<http://www.gci-net.com/>

GetNet, Inc.
Phoenix
(602) 264-7000
<http://www.getnet.com/>

Here, Inc.
Flagstaff, Glendale, Paradise Valley, Peoria,
Phoenix, Prescott, Scottsdale, Tempe
(602) 276-8200
<http://www.hereinc.com/>

Infinet Internet Services
Phoenix Valley metro area
(602) 224-0123
<http://www.infinet-is.com/>

InfoMagic Internet Services Ltd.
Flagstaff, Paradise Valley, Phoenix, Phoenix Metro,
Prescott, Scottsdale, Tempe
(520) 526-9565, (800) 800-6613
<http://www.infomagic.net/>

Internet Access Inc DBA or GetNet
Phoenix
(602) 651-7000
<http://www.getnet.com/> or <http://www.neta.com/>

Interwrx.com
Flagstaff, Phoenix metro, Prescott
(480) 892-9393
<http://www.interwrx.com/>

Net-World
Phoenix Valley metro area
(480) 446-9275
<http://www.ntwrl.com/>

Northlink Internet Services
Phoenix Valley metro area, Flagstaff, Prescott
(520) 445-0707
<http://www.northlink.com/>

Opus One
Tucson
(520) 324-0494
<http://www.opus1.com/o/internet.html>

Phoenix Computer Specialists
All of Phoenix metro area, Flagstaff
(602) 265-9188
<http://www.pcslink.com/>

Phoenix Internet
Phoenix Metro and Northern Arizona
602.234.0917 or 877.269.7886
<http://www.phxinternet.net>

PipelineUSA
Phoenix Valley metro area
(480) 540-3927
<http://www.pipelineusa.com/>

Qwest.net
all cities
(877) 490-6342
<http://www.qwest.net/>

The Market Builder
Metro Phoenix, Flagstaff, and Prescott.
480-707-0444
<http://www.themarketbuilder.com/>

The River Internet Access Co.
Phoenix Valley metro area, Tucson
(520) 745-1009
<http://www.theriver.com/>

Velocitus / RMC Internet Services
Phoenix
(888) 275-2643
<http://www.rmci.net/>

Ultra Southwest Internet Partners
Tucson
(520) 624-9404
<http://www.ultrasw.com/>

Velocitus
Phoenix, Flagstaff,
800-219-9996
<http://www.velocitus.net/>

ViaWest Internet Services
Phoenix
(602) 840-8248
<http://www.viawest.net/>

GLOSSARY



Analog	In telephony, an electrical signal that varies in amplitude and frequency according to the characteristics of an outside force, such as someone speaking into a microphone.
Asynchronous	A transmission system in which each network terminal runs on its own clock. A method of data transmission that permits data to be transmitted at irregular intervals by using start and stop bits to signify the beginning and end of each character.
ATM	Asynchronous Transfer Mode is a new way of designing data packets that is particularly suited to the transmission of video and audio information as well as text. Unlike other packet techniques, ATM uses a standard 53 byte packet to substantially reduce delay for voice and video carriage. Besides offering very high speed, ATM is attracting attention because it is favored by phone companies, cable operators, and corporate computer users alike.
Automatic Call Distribution	ACD is a software feature package designed to handle a large volume of incoming calls with a minimum number of resources.
Automatic Number Identification	ANI is a telephony feature that captures the calling party's telephone number and transmits it to the called party.
Automatic Route Selection	The ability of a telephone system to automatically send an outgoing call on the most cost effective line, based on a real-time comparison of the dialed digits with preprogrammed area code/prefix tables.
Backbone	A set of circuits or facilities which interconnect network nodes, much as the spinal cord sends messages to various parts of the human body.
Bandwidth	A measure of how fast a network can move information, usually specified in thousands or millions of bits (units of data) per second.
BER	Bit Error Rate. The ratio of the number of received data bits that are in error, relative to the total number of bits received.
Bps	Bits per second, a unit of transmission rate for digital information.
BRI	ISDN Basic Rate Interface which supports two Bearer (B) channels, each operating at 64 Kbps, and one Data (D) channel operating at 16 Kbps. It is an end-to-end digital service offering by local exchange carriers.
Broadband	A popular way to move large amounts of voice, data, and video. Broadband technology lets different networks coexist on a single transmission medium.
CD-ROM	(Compact Disk-Read Only Memory). The compact disk originally made for audio and now adapted for computer use. Each disk holds as much as 660 Mbytes of information.
Cell Relay	A switching method using fixed length packets (cells).
CIR	Committed information rate, Frame Relay Bandwidth allocation.

GLOSSARY



Central Office	The CO is the location which houses the telephone company's switching equipment.
CRC	Cyclic Redundancy Check, a 16 bit polynomial used as checksum.
CSU - Channel Service Unit	A device that is inserted into digital circuit that provides loop around and other testing capabilities for carriers.
Circuit	A connection between two points over which information is exchanged.
Client-Server	Computer architecture under which files and services are shared among multiple users.
Coaxial Cable	Cable installed for cable TV and some data networks. It consists of a center conductor surrounded by a shield. It has more capacity than a twisted pair but less than a strand of fiber optic cable.
Codec	Coder-Decoder that converts between analog signals (voice or video) and digital formats, usually compressed for transmission over a digital medium.
Common Carrier	A licensed utility that provides leased communications services under nondiscriminatory tariffs.
CSMA	Carrier Sense Multiple Access. Ethernet media access protocol.
CSMA/CA	CSMA with collision avoidance.
CSMA/CD	CSMA with collision detection.
Customer Premise Equipment	CPE is any communications equipment which resides on the customer's premises, located behind the demarc.
Cutover	The point in time when old service or equipment is turned off and new service or equipment is turned on.
DACS	Digital Access and Cross-connect System, a digital switching device which is the electronic equivalent of a wiring frame for circuit switching through a central office.
DS-0	Digital Service level 0 (a 64 Kbps channel, capable of carrying a single voice or 56/64 Kbps data channel).
DS-1	Digital Service level 1 (a 1.5 Mbps channel, used as a single wideband channel for video conferencing or as 24 segmented DS-0 voice/data channels), comparable to a T1.
DS-3	Digital Service level 3 (a 45 Mbps channel, used for broadcast quality video or as 28 T1s or 672 DS-0 voice/data channels), comparable to a T-3.
Data Service Unit -DSU	A device that is inserted in a digital circuit that provides loop-around and other testing capabilities for carriers. It also provides a data interface (RS-232, RS-449, V.34, etc.) to digital devices.
Datagram	A single packet self contained message.

GLOSSARY



Data Terminal Equipment	DTE is hardware that provides for data communications.
Dedicated Connection	A private circuit between two points that operates for the exclusive use of one customer.
Demarcation	Point that separates services provided between various vendors or between a vendor and the customer. The common carrier's circuit responsibility ends and the customer's responsibility begins at the demarcation point.
Desktop Video	Video teleconferencing capabilities provided on a personal computer.
Digital	Representation of information by the use of 1s and 0s (also called bits).
Digital Broadcast Satellite	A new satellite technology that digitally compresses the video signal to provide several channels per satellite transponder. A high powered satellite operates with a small diameter customer premises dish antenna.
Digital Compression	A technique that reduces the number of bits used to represent an analog signal.
DSP	Digital Signal Processor.
DSL - Digital Subscriber Line	A copper wire local loop conditioned to provide high speed digital access to internet service providers. DSL is generally limited to distances under 15,000 feet between the user site and the CO. DSL is offered in many forms including: ADSL, HDSL, IDSL, RADSL, SDSL, VDSL, and most recently, G.SHDSL
Direct In-Dialing	DID is a telephone company service that allows a local outside caller to dial a seven digit number and ring the telephone of the desired department or individual.
Electronic Key Telephone System	An EKTS is a small premises based user owned telephone switch.
Electronic Mail (email)	A "store and forward" service for the transmission of textual messages in machine readable form from a computer terminal or computer system. A message sent from one computer user to another is stored in a "mailbox" until the recipient next logs onto the system and the message is delivered.
Ethernet	A common local area networking (LAN) technology. Computers are connected together on a "shared-bandwidth link."
FDDI	Fiber Distributed Data Interface, data transmission protocol standard for the movement of information between LANs (or MANs) at a fixed (and shared) rate of 100 Mbps; FDDI-II and FFDL are extensions of existing FDDI specifications; CDDI is a copper equivalent.
Fiber Optic Cable	Made of glass instead of copper strands, fiber transmits data expressed as pulses of light rather than electrons. Light pulses are generated by lasers or other devices. Optical fiber can carry billions of bits per second, many times more than coaxial cable or copper wire, and is virtually impervious to electrical interference.
FRAD	Frame relay packet assembler/disassembler.

GLOSSARY



Frame Relay	A fast packet technology similar to X.25; channelized in 64 Kbps x N,
IEEE 802	IEEE LAN architecture standard. 802.2 is the Ethernet standard; 802.5 is Token Ring; 802.11x is the wireless standard series.
ISDN - Integrated Services Digital Network	A digital service offering that enables both voice and data to flow over a standard phone line. 64 Kbps local loop telephony integrated over ATM transport at the Central Office. Also, a set of standards for a digital public network equivalent to the current analog PSTN.
Inter-exchange Carrier (IXC)	A common carrier authorized by the FCC to offer interLATA long distance services.
Internet	A worldwide network of computer networks running under the Transmission Control Protocol/Internet Protocol and providing computer access to the world wide web, electronic mail services, databases (including library catalogs), and file transfer capabilities.
Internet Protocol (IP)	The Internet standard protocol that defines the Internet datagram as the unit of information passed across the Internet and provides the basis for the Internet connectionless, best-effort packet delivery service. IP includes ICMP control and error message protocol as an integral part.
Interoperability	The capability for different computers, networks and applications to work together.
Intranet	A private closed internet-type service in which access is restricted to authorized users within a group, typically a corporation or government agency.
Local Access and Transport Area - LATA	A defined geographical area where local telephone companies have rights to provide switched telecommunications services. IXCs depend on LECs for origination and termination of most circuits.
Local Area Network - LAN	A data communications network typically covering a building or campus that links together computers and peripheral devices, such as printers, under some form of common control. The LAN allows connected devices to access centralized databases, to send and receive messages, and to work with other connected devices on the local network.
Local Exchange Carrier - LEC	Local telephone company authorized to provide local exchange and intraLATA services. Since deregulation Competitive LECs (CLEC) can operate in the same service areas as the Incumbent LECs (ILEC).
Metropolitan Area Network - MAN	A type of WAN that is generally restricted to a metropolitan area.
Network	A system of computers and other hardware and software that is connected and enables users to transmit and receive data and messages reliably.
NIC	Network Interface Card.

GLOSSARY



OC-1	Optical Carrier level 1, lowest capacity SONET transmission rate of 51.84 Mbps, roughly equivalent to a DS-3 or 672 DS-0 channels.
OC-3	Optical Carrier level 3, medium capacity access SONET rate of 155.52 Mbps, equivalent to over 2000 DS-0 channels.
OC-12	Optical Carrier level 12, high capacity access SONET rate of 622.08 Mbps, equivalent to over 8000 DS-0 channels.
OC-48	Optical Carrier level 48, SONET transmission rate of 2.488 Gbps, typically used to interconnect IXC POPs, or for very high speed data applications, equivalent to 48 DS-3s or 32,256 DS-0 voice/data channels.
OSI	Open Systems Interconnect. A 7-layer hierarchical reference structure developed by ISO for defining, specifying, and relating communications protocols.
Packet	A small block of data that is routed through a network. It usually includes an address and error detection codes.
Packet Switching	A method of sending blocks of digital data. Unlike on a dedicated circuit, a path is only in use while a transmission occurs.
PCS	Personal Communication Services.
PDA	Personal Digital Assistant. Hand or pocket carried data processing computer.
POP	Point of Presence, point where IXC connects to LEC or via bypass directly to user premises, <i>e.g.</i> , State offices, educational TV stations, universities, etc.
RFP	Request For Proposals.
PPP	Point-to-Point Protocol, a type of communication protocol often used for serial Internet connections, usually via modem.
PRI	ISDN Primary Rate Interface which supports 23 Bearer (B) channels, each operating at 64 Kbps, and one Data (D) channel operating at 64 Kbps. Uses a T1 line for access.
Private Branch Exchange - PBX	A PBX is a switch on a customer's premises that connects his private telephones to each other and to the public network.
Private Line	A dedicated telecommunications circuit between two points.
Protocol	A specific set of rules, procedures, or conventions relating to format and timing of the transmission of data between two devices. A standard procedure that two data devices must accept and follow so as to understand one another.
PSTN	Public Switched Telephone Network.
PVC	Permanent Virtual Circuit, pre-assigned over a cell switching network, not user switchable.
Router	A device responsible for making decisions about which of several paths network traffic will follow. In the Internet, each IP gateway is a router that uses IP destination addresses to choose routes.

GLOSSARY



SDLC	Synchronous Data Link Protocol.
SNA	Systems Network Architecture.
SLIP	Single Line IP, a protocol used to connect a single host to an IP network over a serial line, such as a telephone line.
SNMP	Simple Network Management Protocol. Widely accepted standard protocol for managing data networks.
Synchronous Optical Network - SONET	A standard for transport that defines optical carrier levels and their electrically equivalent synchronous transport signals. SONET allows for a multi-vendor environment, positions the network for transport of new services, and synchronous networking. The SONET standards for digital transmission are from 51.84 Mbps (OC-1) through 4.977 Gbps (OC-96) and beyond.
TCP/IP	Transmission Control Protocol/Internet Protocol, a standard language with which devices communicate over a network.
Telco	The local telephone company or Local Exchange Carrier (LEC).
T1 or DS1	A digital telecommunications private line circuit, operating at 1.544 Mbps, that can carry 24 voice conversations or other types of digital data.
T3 or DS3	A digital telecommunications private line circuit, operating at 45 Mbps, that can carry 672 voice conversations or other types of digital data.
Teleconferencing	The conferencing of parties using telecommunications facilities. The term is usually used to mean more than two voice parties or two or more video parties.
Token Ring	A local area networking scheme that is associated with IBM. The term comes from a type of data packet, called a token, that keeps multiple computers on a network from talking at once.
Transmission Control Protocol - TCP	The Internet standard transport level protocol that provides the reliable, full duplex, stream service on which many application protocols depend. TCP allows a process on one device to send a stream of data to a process on another. It is connection oriented in the sense that before transmitting data, participants must establish a connection. Software implementing TCP usually resides in the operating system and uses the IP protocol to transmit information across the network. The Internet protocol suite is often referred to as TCP/IP.
Trunk	A line between the telephone company central office and a customer premise - typically to a PBX.
Twisted Pair	The most convenient and inexpensive type of local wiring for networks. It consists of single or multiple pairs of small gauge copper wires, each twisted to minimize interference pickup and radiation.
Wide Area Network (WAN)	A network of multiple local networks tied together, typically using telephone company services. WANs may connect users in different buildings or countries.

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